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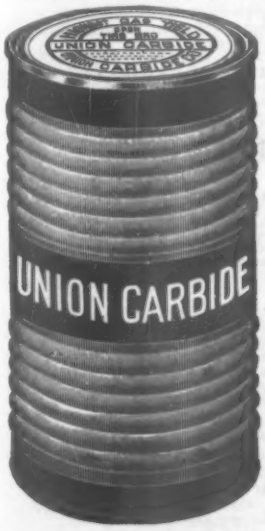

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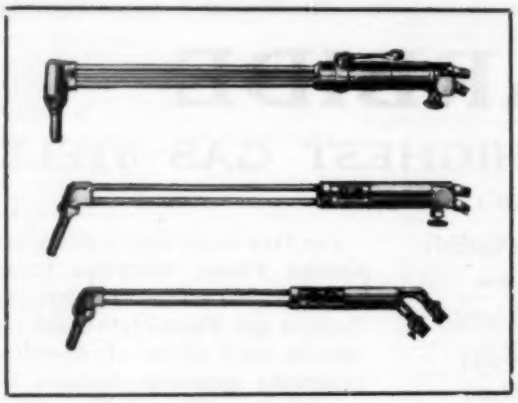

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Any Length Desired
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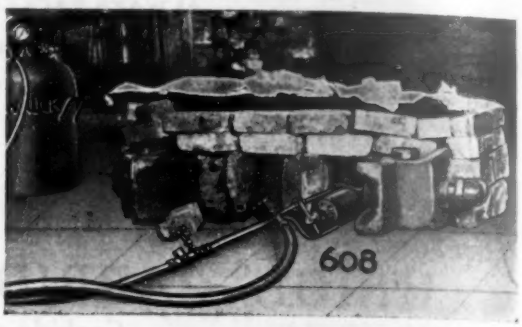
HAUCK PREHEATERS
20 YEARS OIL BURNER EXPERIENCE



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They do the work in much quicker time with the elimination of noxious gases, smoke and ashes.

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Modern Engineering Co.
Transportation Engineering Corp.
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Transportation Engineering Corp.
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D. & W. Fuse Works, General Electric Co.
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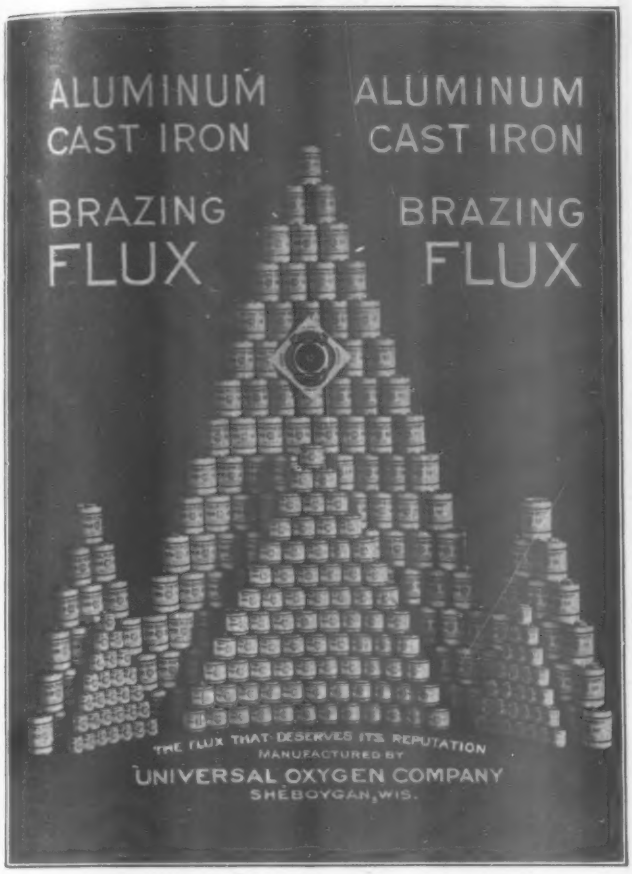

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MALLEABLE IRON
NORWAY IRON
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FLUXES FOR WELDING
ALL MATERIALS

QUALITY GUARANTEED

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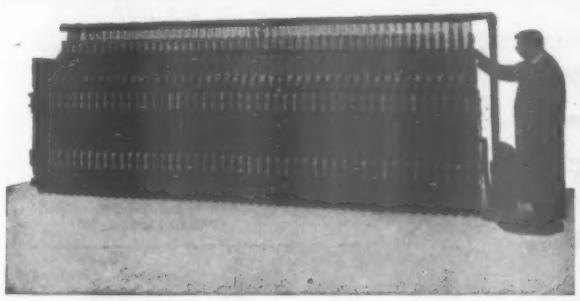

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SAVES MONEY
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EFFICIENCY in cutting and welding operations
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BUILT UP TO A STANDARD

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A QUALITY INSTRUMENT THAT IS THE MARK OF DISTINCTION FOR THE FINEST REGULATORS and EQUIPMENT

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"Weld-a-cast" is a scientific combination of chemicals, that causes the metal to melt rapidly shortening the operation, thus economizing in time, gas and oxygen.

"Weld-a-cast" adheres readily to the hot welding rod which picks up just enough and none is wasted; it does not blow away but melts at once; it eliminates blow holes and leaves the metal soft.

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MECO MULTI-SEAT REGULATORS have four seats instead of one, but cost no more.

Write for prices and start to reduce your costs — NOW.

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The mild steel used in the manufacture of "Raco" Electric Welding Wire is made by the open hearth process, the wire is made by the Reid-Avery Co., which should not be confused with jobbers.

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"Raco" Manganese Composite Electrodes

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Door hinged at arrow, all helmets are fitted with

Essentialite Lenses

Style "P"

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can be produced in your plant by LEVIN CELLS, as you need it, at a fraction of the cost of oxygen in tanks. The LEVIN CELL is simple and safe to operate, and it produces oxygen that is 99.8% pure.

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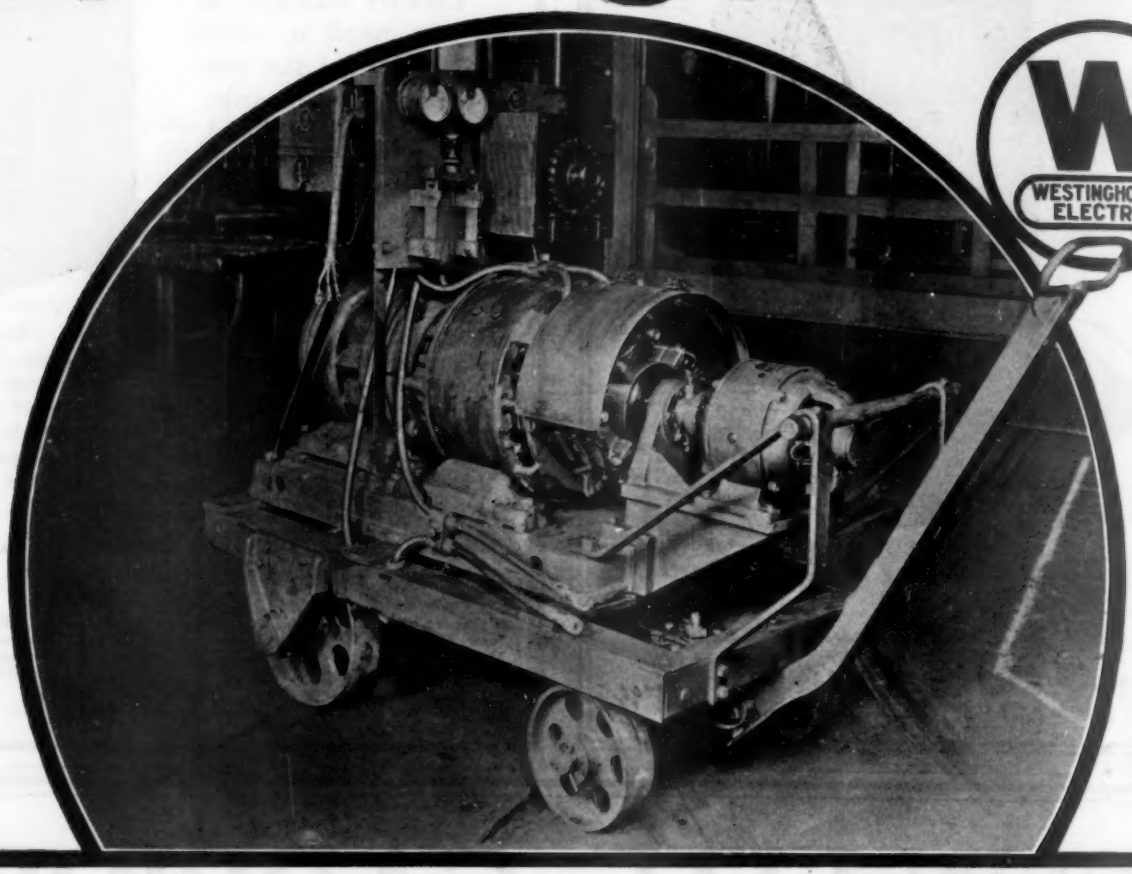

Deeper Penetration—Better Fusion and More Welds Per Day

Ten points of the Westinghouse welding equipment that assure economy of operation, good penetration and the proper fusion:

1. Easy to strike and to hold arc.
2. Reactor of low inductance.
3. Proper penetration of deposited metal.
4. Small current steps; less than 10 amperes.
5. Twenty-one current steps obtained by adjusting only one device; namely, field rheostat. No change in rheostat setting required while changing from downward or vertical welding to overhead welding.
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7. A-C motor provided with outside terminals for connecting for 220 or 440 volts.
8. Control panel mounted over set, making it compact and requiring minimum floor space.
9. Ammeter and voltmeter supplied on panel. Operator can readily check current and polarity.
10. Covered generator commutator and radial self-aligning ball bearings for set and exciter.

Bulletin 7149 is a valuable reference book on arc welding applications and the advantages of the Westinghouse arc welding equipment. Write for a copy.

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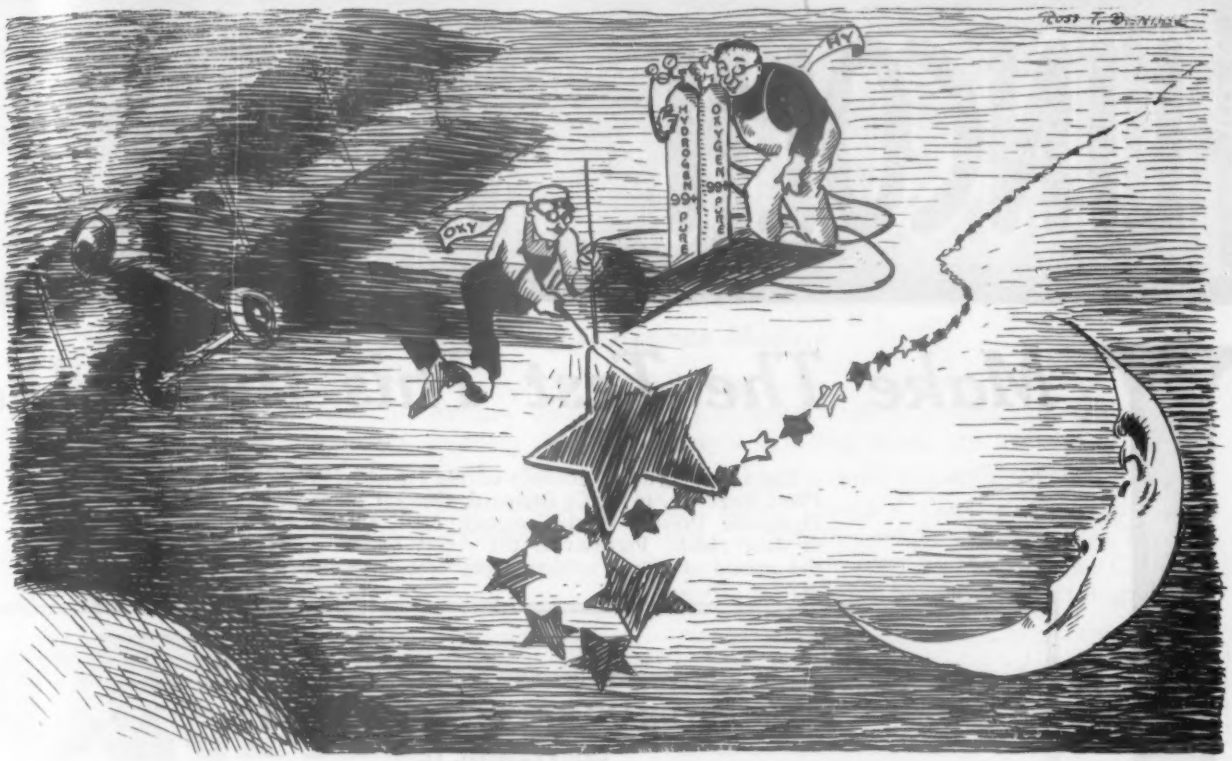
EAST PITTSBURGH, PA.
Offices in All Principal American Cities

Arc Welders



Oxy—Say Hy. An astronomer told me that light travels at the rate of 186,000 miles per second.
Hy—That may be so, but it never reaches some people.

Only recently a scientist measured the star Betelguese and found that it is the biggest star in the heavens. The biggest thing in the welding and cutting industry is electrolytic Oxygen and Hydrogen 99% pure or better. You don't need a telescope to discover this; a few tests will suffice.

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National Oxygen Co., Chicago
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Logansport Oxygen Co., Logansport

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Bettendorf Oxygen Hydrogen Co., Bettendorf

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MANITOBA
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Michigan Ox-Hydric Co., Muskegon
National Oxygen & Machinery Co., Detroit

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Gas Products Co., Columbus
Ohio Electrolytic Oxygen Co., Cincinnati

OKLAHOMA
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OREGON
Portland Oxygen & Hydrogen Co., Portland

PENNSYLVANIA
Burdett Oxygen Co., Philadelphia (plants at Chester and Norristown)
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National Oxygen, Erie

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Whitmore Oxygen Co., Salt Lake City

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Compressed Gas Co., Ltd., Vancouver

Gas Products Association

801 Marquette Building **Chicago, Ill.**

LINCOLN ARC WELDER

Make The Test This Buyer Did

The following is a facsimile of the report of W. E. Irish, Plant Engineer, to G. C. Brainard, General Manager of The Hydraulic Pressed Steel Company, relative to a test made in their plant. Portions of the report which would reveal the names of other welding equipment have been cut out.

INTER-DEPARTMENT COMMUNICATION

The HYDRAULIC PRESSED STEEL CO.

CLEVELAND, O.

ATTENTION OF Mr. G. C. Brainard, GENERAL MANAGER. DATE March 20th, 1920

SUBJECT: Arc Welding.
REFERENCE: Telephone request for figures on performance.

On comparative test run in this plant on three makes of welding machines, on Feb. 10th, 1920, the following results were obtained:

Make	Diameter Wire	Time to weld 2 ft.
Lincoln	3/16	6 mins. - 10 sec.
Welder "B"	3/16	8 mins. - 20 sec.
Welder "C"	5/32	13 mins. - 0 sec.

The test was started using 3/16 wire on all machines, but was changed to 5/32 on the Welder "C" as it was impossible to hold a steady arc with the heavier wire and get a good weld. This of course slowed up the Welder "C" set as there were more changes of wire to make.

The Lincoln Arc Welder will do at least 20% more welding work per day under actual commercial welding conditions than any other electric welding equipment made.

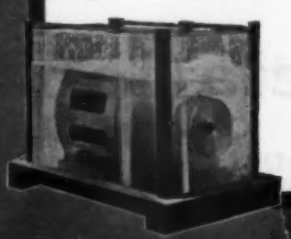
This is a well considered statement based on results of many competitive tests, and The Lincoln Electric Co. are prepared to prove the claim at any time or place where welding is being done by commercial operators.

"Link Up with Lincoln"

THE LINCOLN ELECTRIC CO.

General Offices and Factory, Cleveland, O.

The Lincoln Electric Co., of Canada, Ltd., Toronto-Montreal



This Standard Lincoln Motor operated over 3 years under water without damage.

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WELDING RODS

Parsons' Manganese Bronze Rolled Welding Rods

the Strongest Bronze Made

for high-fire Brazing and Oxy-Acetylene Welding of Malleable Iron or Bronze and Brass castings assure a faultless, flawless job. This is another example of the "Cramp" standard of quality. This scientifically perfected metal is the result of long years of experience. Its fine physical properties make it especially suitable for welding purposes.

A strong weld of fine close grain and exceedingly tough texture is always the result where Cramp's Welding Rods are usesd.

We can also furnish Welding Rods of Cramp's Cast Iron, Cramp's Copper Covered Iron, Cramp's Vanadium Steel, Cramp's Drawn Aluminum, Cramp's Cast Aluminum, Cramp's American Iron and Soft Brass Brazing Wire.

CRAMP

We furnish and will be glad to estimate on all kinds of brass and bronze castings.

The William Cramp & Sons Ship & Engine Building Co., Philadelphia

hose who have enjoyed long association with CANADIAN CARBIDE have always assumed high standards of performance We are confident that if not already among the users of CANADIAN CARBIDE the day will come when you too will know the meaning of "More Gas per Pound"

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Oxy-Acetylene Oxy-Hydrogen

OXY-ACETYLENE WELDING
DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.

Backed by the longest service, greatest development, and widest practical experience in application.

Time—Efficiency—and the Greatest Number of Successful Users—have made Davis-Bournonville apparatus the standard for comparison in the Oxy-Acetylene industry.

Everything for Welding and Cutting—

From a Welding Torch to a Welding Machine.

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Bulletins for your every requirement—ask for them

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Johnston Aluminum Welding Goggles

No. 304

The Lightest Weight Welding Goggle

The Johnston Aluminum Welding Goggle complete with lenses weighs 1½ ounces. How does your present goggle compare?

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The lenses are genuine Weldoglas which have met with universal favor in our fibre goggles. They screen out the harmful rays and permit good vision. Clear cover glasses protect the welding lenses.

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"FEDERAL" Regulators have been passed by the National Board of Underwriters. Should a diaphragm, for any reason, become ruptured, the gas is released through special vent holes at the rear end of the front cap, absolutely preventing any possible chance of physical injury to the operator.

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The Name is Your Guarantee

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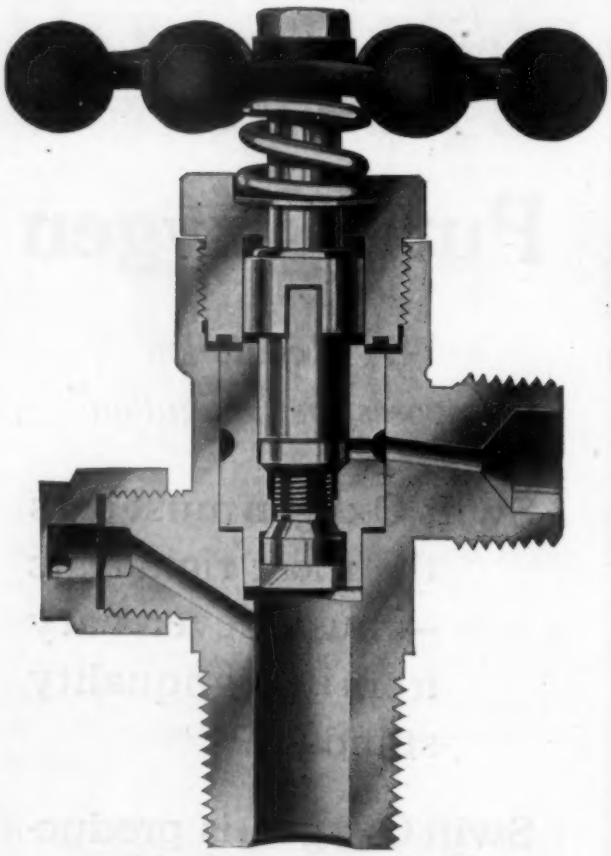

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Bears the BURDETT trade mark and conforms to the BURDETT standard of excellence of design, material and workmanship.

22 Points of Merit

Construction

1 Two valve seats instead of one.
2 Upper valve stem made of Aterite Metal.
3 Lower valve stem made of Monel Metal.
4 Lower valve stem screws into upper stem, putting terrific pressure on both seats.
5 Valve body made of pressed brass casting.
6 On account of its construction the valve is practically indestructible.
7 The only valve that has a positive metallic seal interposed between the gas in the cylinder and the valve.

Operation

8 Easiest operating high pressure valve in gas service today.
9 Valve opens wide with one and one-half turns of handle.
10 Can easily close valve with thumb and one finger when pressure in cylinder is 2,000 pounds.

Gas Leakage Eliminated

11 No stuffing boxes.
12 No soft metal seats to wear and give trouble.
13 The higher the pressure in cylinder the tighter the valve closes.
14 The gas pressure in cylinder forces bottom valve stem against its own seat.

Reduces Valve Repairs to a Minimum

15 Owing to its easy operating features it is not necessary for gas consumers to use a wrench to open and close valve, thus stopping the replacing of broken valve stems.
16 No complicated parts and discs to give trouble and the constant replacing of such parts.

Why Your Customers Will Like the Burdett Special Valve

17 They can easily turn on small amount of gas avoiding destructive shock and strain on gauge and regulator.
18 Insures them against low pressure cylinders.

How It Helps Gas Manufacturers

19 By loosening the large nut on top of valve inside movable parts come out, leaving body of valve in cylinder open for cleaning and flushing with hose.
20 Not necessary to remove valve body when cylinder is subjected to the quinquennial test.
21 Plant operators will save gas for Manufacturer because valve can easily be closed tight.
22 Eliminates issuing credits to customers for gas shortages and all valve complaints.

The BURDETT Line Includes

Electrolytic Oxygen and Hydrogen Gas Plants.
Master Valves for charging stands.

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In our welding supply department we carry the largest and most complete stock in the middle west. Attractive prices and prompt shipments of either gas or electric Welding Rods. Immediate delivery on small orders or car load lots.

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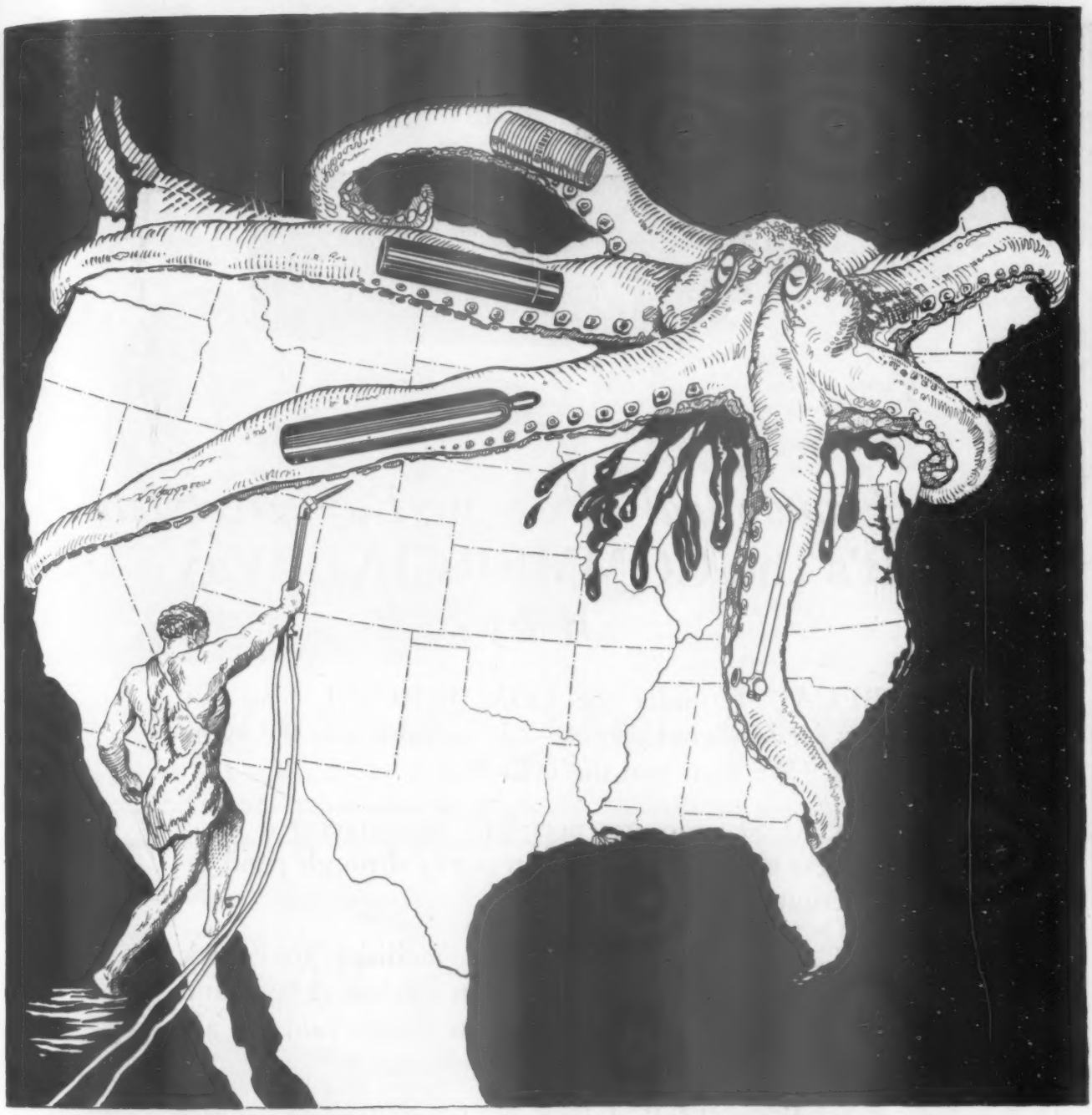

1921 Will Reward Fighters

Every maker and user of gas welding and cutting apparatus is concerned in the Milburn declaration of principles:

Open and unrestricted markets.
Fair competition.
Good faith with all competitors in word and deed.
Freedom that encourages initiative.
Goods sold only on their merit, building reliability in buying personnel.

Progress in the welding industry is possible only by adherence to these Milburn Principles.
Your own best interests, present and future, urge your active support. Write for news of latest developments in the Milburn Crusade.

THE ALEXANDER MILBURN COMPANY

Manufacturers of Oxy-Acetylene Welding and Cutting Apparatus
Carbide Lights, Generators and Accessories

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The Economical Way to Buy Acetylene?
It's the COMMERCIAL Way.
Why?

BECAUSE under the COMMERCIAL plan you pay for just what you use—the gas that's in the cylinders. We loan you the cylinders.

BECAUSE you get acetylene manufactured by a process that insures uniform purity through rigid inspection.

BECAUSE COMMERCIAL facilities for quick service at all points protect you against delays, and COMMERCIAL engineers can render valuable aid on your welding and cutting problems.

Acetylene supplied in portable cylinders of the following sizes and capacities:

10	in.	x 30	in.	size	-	125	cu. ft.	capacity
12	"	x 36	"	"	-	225	"	" "
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Submit your acetylene requirements to our nearest office.

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WILSON Plastic-Arc SYSTEM
(TRADE MARK)

The only effective welding metal for machinable cast iron welds without studs is found in
Plastic-Arc
Certified Welding Metal.
Grade No. 12.

WELDED THIS TANK

and this System has been adopted by the Welded Products Company of Birmingham, Alabama, to weld all their tanks. They have found it much cheaper in cost than riveting or acetylene welding, much quicker and productive of a stronger, tighter joint.

The tank is 10′ x 30′, holds 18,000 gals., is made of ¼″ plate, with 5/16″ flanged heads. All seams are **Plastic-Arc** lap-welded inside and out.

For an arc welding system that is different—unusually effective, and economical, it will surely pay you to investigate the Wilson **Plastic-Arc** System, the only guarantee of *constant heat per unit area in the weld.*

Literature and prices promptly on request.

WILSON WELDER & METALS COMPANY
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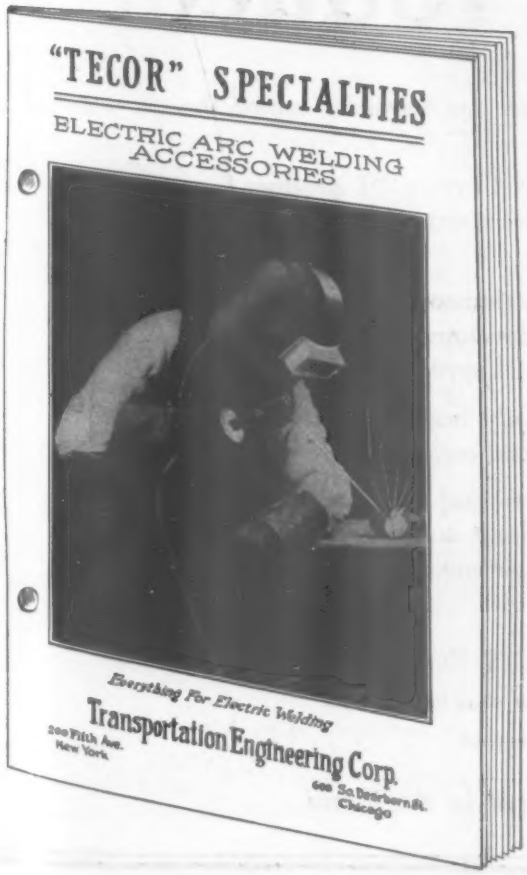

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ONE hundred and forty-four years ago Lavoisier coined the name *Oxygen.*

In choosing the Greek word Γεννάω "I produce," as his main root he had in mind a chemical reaction commonly associated with the gas.

Had Lavoisier been able to foresee the tremendous part that Linde Oxygen is playing in modern industrial development, he would have realized the vast significance of that word Γεννάω "I produce."

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PRODUCTION WELDING

ONE of the most marked peculiarities of the business that comes to the door of the average welding shop is the tendency to suddenly vary in volume. One day the entire force will be on the jump from morning 'till evening, with part of them working overtime on the repair of an exceptionally heavy casting, which naturally calls for a prolonged and continuous performance of preheating and welding, and the next day the boss finds himself puttering around the shop in search of jobs to keep the men busy. Quite naturally all repair work is wanted in a hurry, since a broken piece of machinery means a machine standing idle, so there is a limit to the amount of work that can be carried over for the sake of having something for all the welders to do. Shall the welder sit down calmly, when he has finished one repair, and wait for something else to break? Not if he can help it. If it is a good sized shop there is probably a salesman out looking for machinery accident cases to hustle in for treatment, and if things refuse to break he investigates manufacturing processes to see if he can have parts of products sent to his shop to be assembled by welding. The names "Blank Welding and Mfg. Co." and "Blank Welded Products Co.," so frequently found over the doors of welding shops, indicate that production work is an important part of a thriving welding business.

A considerable volume of production welding for outside concerns has to be secured on each job in order to make the work profitable, because it requires practice to obtain sufficient speed on the work to justify making a price that will mean a saving to the manufacturer. Very often it is necessary to go to the trouble of making special jigs for holding the parts, or to the expense of having them made. Still the work is worth while if the price paid for it is enough to cover all the overhead with a slight margin of profit, for it can usually serve to keep the shop busy during the slack days.

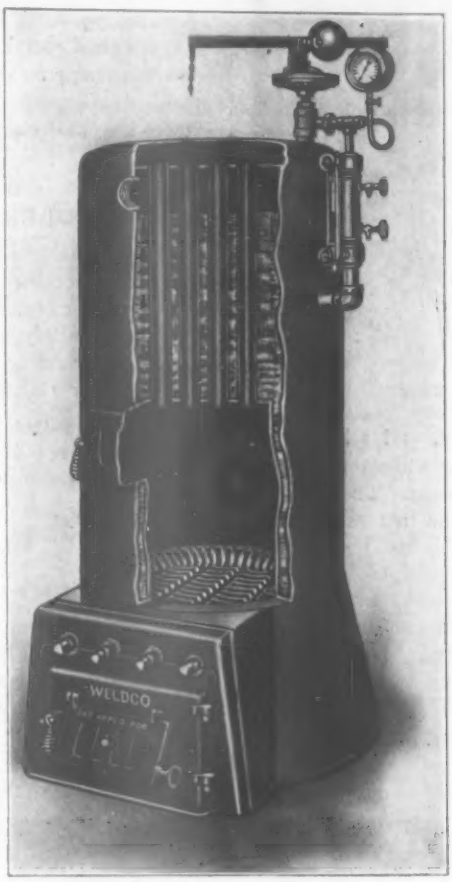


Fig. 1. All Welded Boiler

When all other signs fail, that is, when repair work inside and outside the shop falls off, and there is no demand for production work from other manufacturers, the welder still has a chance to keep busy by becoming a manufacturer himself. There is an almost unlimited number of metal specialties which can be turned out at small cost in a well equipped welding shop, and for which a local demand can be found. The metals can be obtained in sheets, rods, tubes, plates, etc., and to cut to any desired pattern with a cutting torch, then welded together at odd moments, so that the cost of manufacturing is comparatively low. Some interesting work of this nature has been done by the Cave Welding and Manufacutring Company, of Springfield, Massachusetts. This shop is equipped with half a dozen acetylene welding stations, a motor-generator arc welding set, two acetylene generators, a preheater that has assisted in the welding of over five hundred cylinder blocks and heads without record of a failure, and a traveling chain hoist that handles castings in any position. In addition to a big volume of repair work and manufacturing this company does a good sized business in welding equipment and supplies.

One of the manufactured products of the above mentioned company is the electrically welded steel steam and hot water heating boiler illustrated in Figure 1. A steel tubular boiler is generally recognized as the most efficient for power purposes, but its merits have not been applied so largely for heating purposes. It is apparent, however, that the same principles govern in both cases—all other conditions being equal. The efficiency and economy of a boiler of the type illustrated are due to several causes: it gets up steam quickly, and gives very satisfactory service with little attention; it operates efficiently on pea coal which sells for less than the sizes required for some other types of boilers; it is quickly and cheaply installed—nothing to take apart or put together, which means a saving of time and expense; and it eliminates the possibility of cracked or broken sections, with the resulting annoyance of being without heat when heat is most needed.

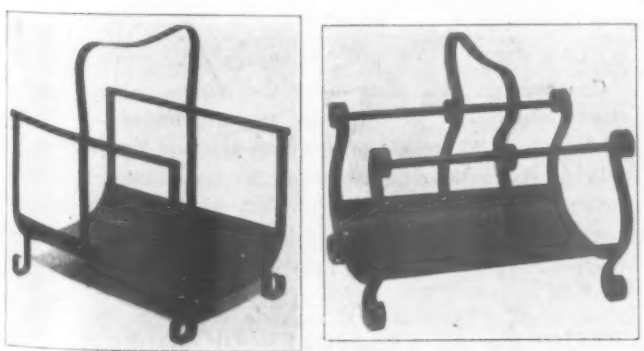


Fig. 2. Two Artistic Wood Baskets

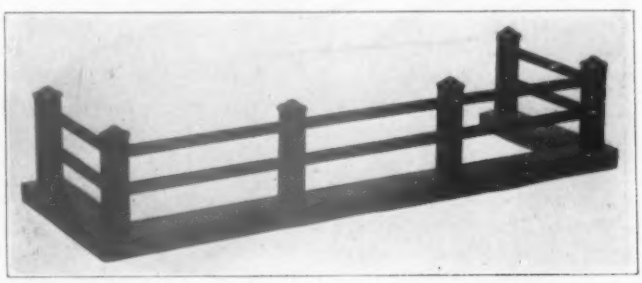


Fig. 3. Fireplace Guard Rail Made in a Welding Shop

Tests on a 21-inch heating boiler of this type were made at Sheffield Scientific School, Yale University, with the following result:

Fuel Used—Pea Coal

Capacity developed feet of radiation..... 760

Rated capacity (assumed)	650
Pct. of rating developed	117
Water fed to boiler per lb. coal fired	9.96
Equiv. evap. per lb. of coal as fired lb	10.05
Cal. value of 1 lb. of fuel as fired B.t.u	12650
Efficiency of boiler and grate	77.0

Professor E. H. Lockwood, M. E., under whose direction the above test was made, noted the ability to get up steam quickly; the small amount of draft needed, and the economy of fuel.

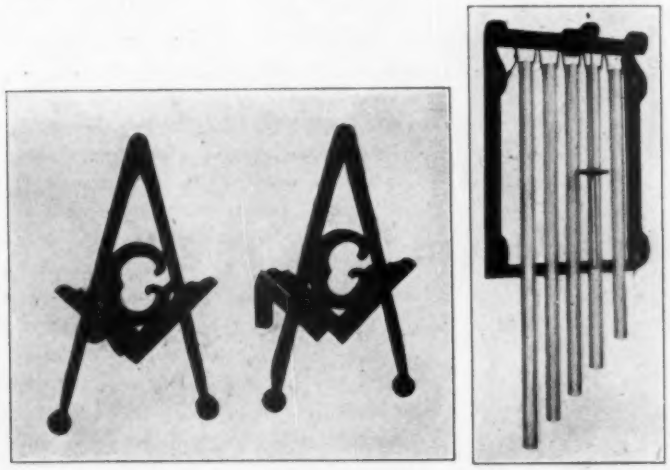


Fig. 4. Andirons and Dinner Gong

These boilers are all steel construction, and all joints are electrically welded. Installation is simply a matter of setting in position and making the pipe connections. The following specifications of two popular sizes may be interesting to the reader:

Fire Pot Diameter	Height of Boiler to Top of Smoke Dome	Height Water Line	Outside Diameter of Boiler	Number and Size of Inlet Pipes	Size of Outlet	Round Smoke Pipe Diameter	Rated Capacity, Square Feet
18″	64″	50″	22″	2-2″	3″	8″	500′
21″	64″	50″	25″	2-2″	3″	8″	700′

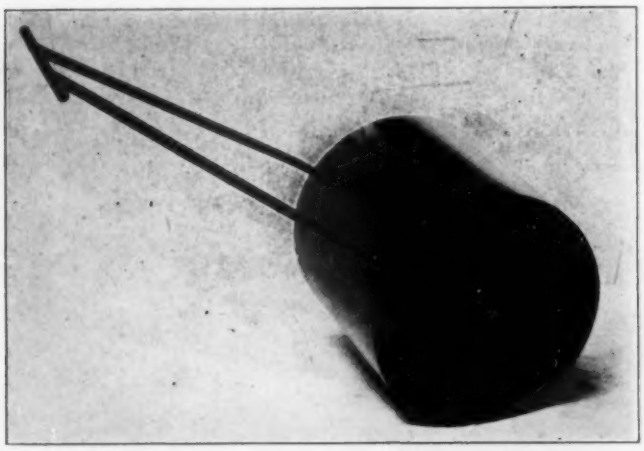


Fig. 5. Welded Lawn Roller

In some of the other illustrations are shown specimens of less elaborate jobs done with the torch or the arc. Fireplaces are plentiful in Springfield and vicinity so there has been a demand for fireplace accessories. Figure 2 shows two artistic designs for all-metal wood baskets which can be made at small cost and sold at a reasonable profit. Figure 3 is a guard rail, easily made from small pieces of tubing and plate. On the left of Figure 4 is a pair of andirons cut out and welded with the oxy-acetylene torch. A good operator can cut these in any required design. The article on the right of Figure 4 is a metallic gong, made from small tubing and sheet metal. Figure 5 is a water tank lawn roll made of sheet metal and light tubing. The construction of all these smaller articles is simple enough, and this collection will serve to illustrate the wide range possibilities for manufacturing work in the job shop.

It will be noted from the photographs that welded products can be made to display the same finished, "classy" appearance as products from an expensively equipped factory. The experienced metal worker will have little difficulty in making all joints square and smooth and all curves well proportioned. And in cases where sturdiness is more essential than appearance, the weld can be made stronger than the rest by reinforcing.

OCTOBER MEETING IN PHILADELPHIA

At a joint session of the Directors' Executive Committee and the Meetings and Papers Committee of the American Welding Society, convened in New York, Tuesday, June 21st, it was definitely arranged to hold the annual autumn meeting of the Society in Philadelphia during the week commencing October 17th next.

The Committee on Meetings and Papers has requested that more members of the Society contribute to its proceedings. Many experienced writers have already done nobly in this respect and it is hoped they will continue but there are also other experienced welding engineers and operators possessed of valuable data which might be utilized in the preparation of papers for presentation to our Society.

Some, perhaps, may think they are not competent to express their thoughts and describe their experiences in proper language for incorporation in the proceedings, hence their refusal to talk or write. Surely, every mechanic can describe, in some form, the interesting experiences he may have had in welding as he must be competent also to express, even though crudely, the theories and deductions formulated as a result of such experiences.

The Society's commitee is very anxious to secure a good supply of papers for presentation during the year and, to that end, seeks your co-operation by prompt response to the seven requests scheduled on appended "Proceedings" questionnaire.

What is your own special line of activity?

What particular subject, experience or interest can you write about?

Will you do it, and when?

Under what caption will you supply your article?

Can you give the Committee the names and addresses of others engaged in welding who might contribute to our Proceedings? If so, please schedule names and topics.

What suggestions have you to offer for making the October meeting program interesting?

Will you present or discuss any particular topic at above meeting? If so, what, and to what extent?

RESIGNED AS TREASURER OF MILBURN CO.

On June 11th, Mr. A. W. Carr resigned as treasurer of the Alexander Milburn Co., manufacturers of welding and cutting torches and acetylene generators. Mr. Carr was associated with the above mentioned firm for over three years.

Hints for the Welder

When you finish an interesting piece of work, can you set down on paper the manner in which you went about the job, how you prepared the work and how the job was done? Have you learned some little stunt every welder ought to know? Contributions to this department are paid for. Write it down any old way – I'll polish it up. Make a rough pencil sketch and our draughtsman will fix it up fine. Line drawings are more practical than photographs. Do it today – the men on the firing line are waiting. L. B. Mackenzie, Editor.

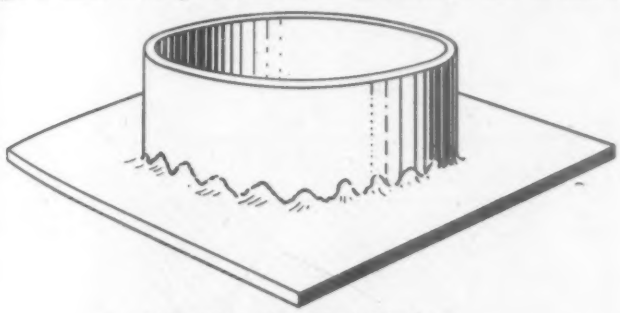
FLUX BOXES

Minneapolis,
Wednesday

Dear Ed:—

Oh, Boy! What do you suppose happened? It stopped raining—the way it was dropping it looked as if it could never stop but I guess the clouds just ran dry. But that's not all. I blew myself to a straw bonnet so don't blame me if my disguise is perfect when I drop in on you the next time.

This communication wont be very long as I'm juggling my pad on one knee trying to hold my place in line to see the P. A. Two fellows are ahead of me so I figured I'd just about have time to make a rough sketch of a little kink, I saw in one of



A Flux Box That Won't Tip Over

the commercial shops here this morning. It's not a great deal but it struck me as being pretty clever, so here it is. Looks very simple to make. The upper part is half of a pipe coupling about 2½ or 3 inches across and it's welded to a piece of fairly heavy plate about 6 inches square.

I've been in so many shops where the flux cans were left standing around, usually right in the welder's way (the whole can getting full of dust) and always being upset so this kink sort of appealed to me. With this box there is no upsetting, it stays put, and holding, as it does, only a small amount of flux at a time, if lumps or dirt get in it, it can be emptied and a new batch put in.

Well, it looks as if I'm next on the program, so, La La.

Shep.

BURNING HOLES IN CONCRETE

In answer to an inquiry for more detained information regarding the use of the oxy-acetylene torch on concrete, a recent contributor to *The Welding Engineer* writes as follows: "I tried the torch on the job for the reason that I had on several occasions accidently touched cement with the flame of the torch, and the result was usually a cracked piece of cement.

"After considerable experimenting on the job above referred to, we decided to use a heavy flame with a No. 9 (Smith) Tip and used an excess of gas in the flame. We kept our generator loaded to about 20 lbs. and had a long tapered flame, as we found that when using a good rose flame we were unable to keep the torch working without considerable back firing. I have some doubts as to the successfulness of this idea on old and dry cement not on the ground, but it seems to work very satisfactorily on green cement or concrete.

"One serious objection to this method is the flying parts of cement and rock, which under the suddent heat disintegrate and fly in all directions; but our experience is that the time saved is so considerable over breaking it out by ordinary methods of maul and chisel that it is well worth trying on any job where there is enough moisture in the cement to furnish expanding gases to disintegrate the mass as the flame hits it."

Another authority states that the process is limited to concrete that is of very recent construction. It appears that after the drying out process has progressed beyond a certain point the difficulties involved multiply so rapidly that the process becomes impracticable. On one particular job the removal was comparatively easy at the start, but became so difficult before it was completed that the work had to be finished by drilling. The inference is that old concrete work that has been sufficiently exposed for the concrete to thoroughly dry out cannot be successfully broken up with the torch and sledge, while concrete that is quite new or that is so situated as to retain considerable moisture may be handled very well.

CONSERVING THE OXYGEN SUPPLY

A writer in Iudstrial Gases points out that, since there is no apparent prospect of lowering the cost of oxygen gas, metal cutters should take steps to lower their operating costs by saving gas at every turn. The first suggestion made is the compilation of tables of average results which should be obtained in cutting steel plates with oxygen. Such a table will be useful in checking the work done by capable operators. The workmen should be supplied with these, and also with comlete copies of instructions issued by the manufacturers of apparatus. Tubing, valves, regulators, and connections should be constantly subjected to examination for leaks. A careful watch should be kept over the pressure of the gas in cylinders, especially those which are not in use, and those which have been used and set aside for a while. When the pressure in a cylinder becomes too low for cutting the remaining oxygen should be used for welding or preheating, if possible. Before returning cylinders the valve should be opened, to guard against the possibility of shipping back a full tank. Inexerienced workmen ought not to be allowed to tamper with the nozzle or the interior of the cutting torch, for this often results in enlarging the opening and considerable wastage. Finally, the operators should be required to shut off both the oxygen and acetylene at once when the cutting is completed.

RESTORATION OF A CRACKED BELL

To weld a crack in a bronze belf is easy enough, perhaps, but to do the work so adroitly as to restore the original tone of the bell is a feat that is apt to be the exception rather than the rule.

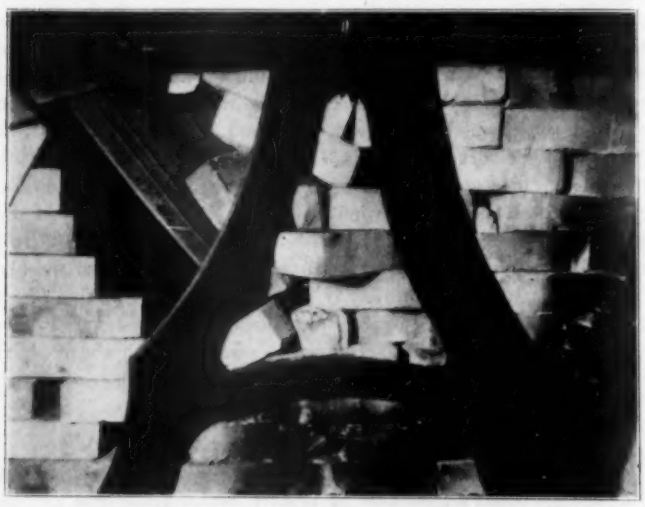
An actual case of such successful welding occurred in Dennison, Ohio, recently. The bell in question hangs in the Presbyterian church in that city. It has been hanging there for fifty years, and, as a matter of fact, is the oldest bell in Tuscarawas County Ohio. It was cracked recently and probably never would have been rung again were it not for the capabilities of the welding process.

The possibilities of oxy-acetylene welding being brought to their attention, and believing their congregation once more could be called to worship by means of this same historic bell, the trustees of the church requested the firm of R. P. Palmer and R. J. Davis of Dennison to weld the bell and if possible restore the original tone. Messrs. Palmer and Davis undertook the job and carried it through to a successful conclusion. The bell was then rung and according to the oldest inhabitants of Dennison, there is no change in its tone.

In Spite of the Size of the Weld, the Original Tone Was Restored

In a letter to the Air Reduction Sales Company, thanking that firm for the excellent service rendered by the Cleveland District Office in connection with securing proper welding rods, Mr. Palmer supplies the following description of the work.

The bell is five feet from lip to lip and weighs sixteen hundred and fifty pounds. The sides are about four inches thick. The metal is a composition of copper and tin, chips like hard brass but welds like copper.



Brick Wall Built Around Bell for the Purpose of Preheating

It was impossible to remove the bell from its position without great cost, so a furnace was built in the belfry for the purpose of preheating. Three hundred and fifty-five bricks were required for the furnace and fifteen bushels of charcoal for the fire. Preheating was necessary to avoid shrinkage crack in the bell when it cooled down at the weld.

The oxy-acetylene torch was used to light the charcoal, and a moulder's hand-bellows for blowing. The bell was heated until it would melt solder. On application of the torch the metal flowed almost instantly.

The crack occurred on the side next to the supporting frame. It was necessary to loosen the bell and turn and tip it until the crack was on a level.

The entire crack was veed out and a piece of boiler steel clamped inside the bell, under the crack, to prevent the molten metal from dropping through.

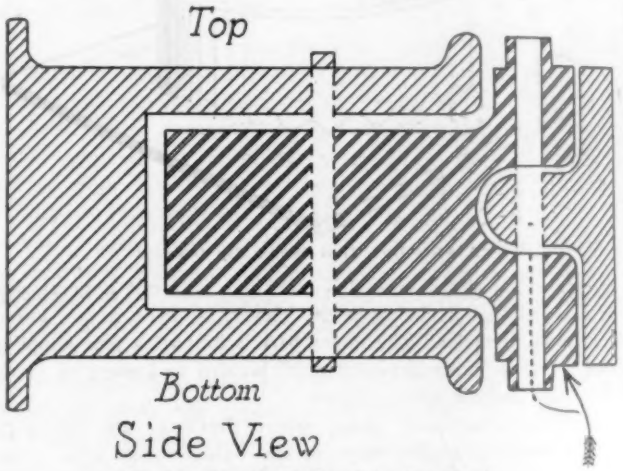
Three hours were required for welding, two cylinders of Acetylene, three of Oxygen and thirty-seven pounds of bronze filling rod being consumed. After the weld was completed it was polished with a small electric grinder.

Messrs. Palmer and Davis were able to secure photographs of the job and these pictures are reproduced herewith.

BROKEN COUPLER

Dear Editor:—

Here is a sketch of a coupler which was on the back end of the tank of an engine that came into the roundhouse for repair. The bottom eye of the coupler was broken off at the point indicated by the arrow, and lost. This job came in the 19th of last April, and I was called upon to weld on a new section. The first thing I did was to get a jack and set it under the coupler, with a fire-brick on top of the jack so it would fit tight against the coupler. Then I took the knuckle out, and I was all ready to weld. I used a mild steel rod to build up the broken off section, and it took just three hours to finish the job. It is a good example of what can be done with oxygen and acetylene, for in the old days it would have meant a new coupler. Up to date the coupler has been doing heavy duty and it still O. K.



Broken Coupler Restored by the Torch

F. R. Esman.

WELDING RECTANGULAR ICE MOLDS

A subscriber asks how to go about welding of rectangular sheet metal cases, to be used for the manufacture of ice. It is important to avoid buckling, because even small wrinkles in the container would prevent the removal of the ice cake. The best way to be sure of a smooth seam is to prepare the stock so that the seam comes in the middle of one of the sides, rather than in a corner. The work can then be handled on a jig similar to that described in the June issue of *The Welding Engineer*. Or, if the seam is too long to permit using a jig of this sort, the slight distortion which does occur can be easily hammered down, a process which would be very difficult if the welded seam were made in the corner.

AN INVESTIGATION OF OXY-ACETYLENE WELDING AND CUTTING BLOWPIPES*

By R. S. JOHNSTON†

This paper reports the results of and conclusions from an elaborate series of tests carried out at the Bureau of Standards, Washington, D. C., on commercial apparatus for cutting and welding by the oxy-acetylene process, submitted by manufacturers for the purpose of the tests.

The test equipment used consisted of a weighing system for determining the weight of the gases used, a system for metering the gases as a check upon the weight and for maintaining standard conditions of pressure and temperature, a welding table for the welding tests, a cutting table for the cutting tests, and a "flashback" and safety testing apparatus for determining the conditions of the flashback phenomena.

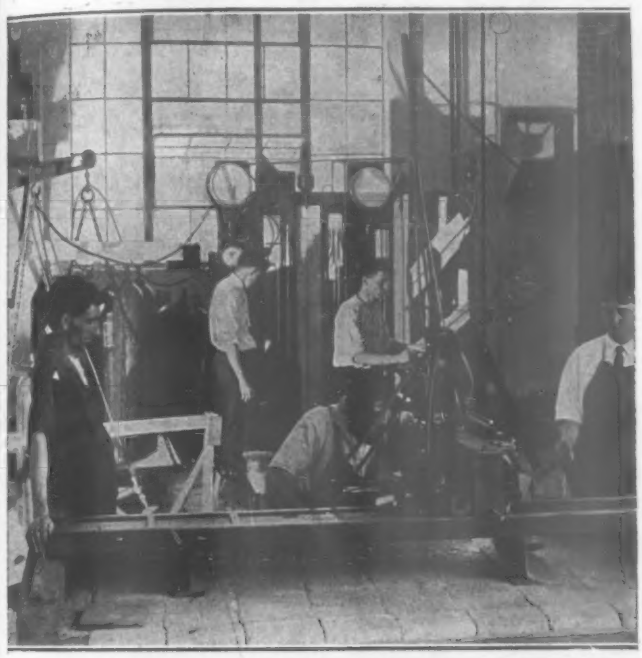


Fig. 1. Entire Testing Equipment

Unusual precautions were taken to insure accuracy in all the tests. For example, the cutting tests were all made by a mechanically controlled cutting device installed on the cutting table, to eliminate the personal equation.

The welding tests were performed upon ½-in. and ¾-in. steel plates, and the cutting tests upon ½-in., 2-in., 6-in. and 10-in. material.

The general conclusions from the tests were that there was a great deal of difference between the characteristics of different designs of cutting blowpipes, and that there was no make of apparatus which was equally proficient and economical for all thicknesses of metal. Further, one of the prime essentials of a good welding blowpipe is its so-called gas ratio, which should be unity. Not any of the blowpipes tested proved capable of maintaining a gas ratio of unity during welding although, as the author states, the welds were probably made with greater care than has ever been bestowed upon any like work.

The important problem of "flashback" receives extensive consideration, and the author concludes by stating that experience gained during these tests indicates that a blowpipe designed to be absolutely free from flashback caused by any form of obstruction, under all working conditions, will also be the eminently safe blowpipe and the one which with ordinary care will produce sound welds. Such a blowpipe will be one so designed that, under all conditions of operation—even to complete blocking of the gas exit at the tip end, there will be maintained a one-to-one volume delivery of each gas, at identical pressures.

*Abstract of paper read before the spring meeting, Chicago, Ill., May 23 to 26, 1921, of The American Society of Mechanical Engineers.

†Engineer-Physicist, U. S. Bureau of Standards, Washington, D. C.

Summary of Results

The results of this investigation would seem to warrant the following statements:

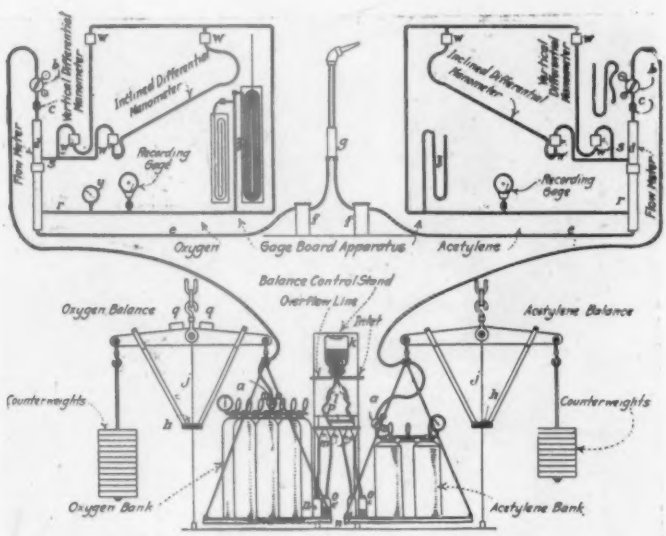


Fig. 2. Diagram of Entire Testing Equipment

For the Cutting Blowpipes:

a That there is today no generally accepted theory for proportioning, for the cutting of metal of various thicknesses, the volume and velocity of the issuing cutting jet, with the result that none of the apparatus submitted to test proved economical for all thicknesses.

b That there is for any thickness of metal cut a limiting velocity of exit of the cutting jet at which complete utilization of the oxygen takes place and a limiting value for the amount of oxygen required to produce a cut.

c That an increase in acetylene consumption, or oxygen consumption, or of the velocity of exit of the cutting jet beyond the limiting values, does not produce increased efficiency in commensurate ratio.

d That a large majority of the blowpipes tested were equipped with excessive preheating flames for the thickness of metal the tip is specified for, and that such excessive-sized flames are disadvantageous both from the standpoint of economy of operation and quality of work performed.

e That considerable improvement in economy of operation seems possible in cutting material of 2-in. thickness and that possibly this condition may be found to exist for metal of other thicknesses than those used in the tests.

f That the maximum thickness of metal that may be economically cut with an oxy-acetylene blowpipe of standard design when neither the material nor the oxygen is preheated and the cutting is done only from one direction, is about twelve inches.

g That cutting blowpipes due to their incorrect design are subject to the same "flashback" troubles found in the welding blowpipes.

For the Welding Blowpipes:

a That the blowpipes most subject to the so-called phenomena of flashback are those in which the oxygen is delivered at a pressure in excess of that at which the acetylene is delivered.

b That all the blowpipes tested, including those in which the acetylene is delivered at an excess pressure as well as the so-called equal or balanced-pressure blowpipes, are subject to flashback phenomena on account of inherent defects in their design.

c That the cause of the development of the conditions producing flashback is the setting up within the blowpipe tip and head of a back pressure which retards or chokes off the flow of one of the gases.

d That this back pressure is the result of confining or restricting the volume flow of the issuing gases at the tip end.

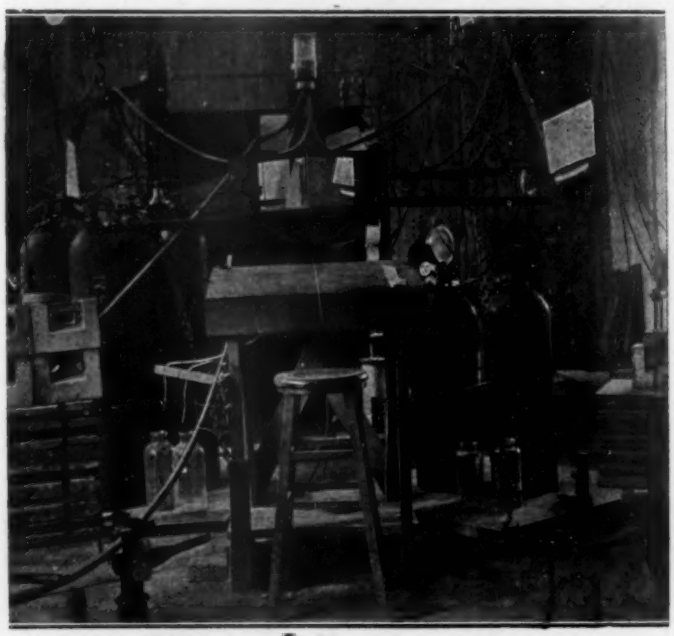


Fig. 3. Operator's Table and Balances

e That any cause tending to restrict the flow of the gases sets up a back pressure which immediately causes a change in the amount of each gas delivered to the mixing chamber.

f That a fluctuating gas-volume ratio, due to restriction of volume flow, from whatever cause, prevents a blowpipe from maintaining constantly and at all times during operation the desired "neutral flame."

g That a blowpipe that cannot maintain under all operating conditions a neutral flame cannot logically be expected to produce sound welds.

h That all the blowpipes tested during this investigation either through improper gas pressures or improper interior design or both are incapable of maintaining a neutral flame (constant-volume gas ratio) under all conditions of restricted gas flow and are therefore incapable of producing sound welds where there is any liability of the gaseous products of combustion being momentarily confined, such as occurs in practically all welding operations.

i That the ability of a blowpipe to consume an equal volume ratio of gases when burning freely and undisturbed in air is no criterion that it is capable of producing sound welds, i. e., that it is not subject to detrimental fluctuations in gas ratio during a welding operation and therefore is capable of maintaining a neutral flame under all operating conditions.

j That whether a blowpipe of present designs will consume an equal volume ratio of gases when burning freely and undisturbed in air depends on how nearly correct the operator sets the so-called "neutral" flame, and experience indicates that the average operator checks the acetylene gas flow too much and actually develops an oxidizing rather than a neutral flame.

k That the question of the possible limiting strength and ductility or the efficiency of welds made by the oxy-acetylene welding blowpipe must await the development of a more satisfactory instrument, and that having such an instrument there is no reason to believe that a weld of clean, sound metal cannot be made with assurance during any welding operation and that such welds will or can be made to possess the proper physical properties.

Description of Equipment Used

In general the equipment used for making the tests may be listed as:

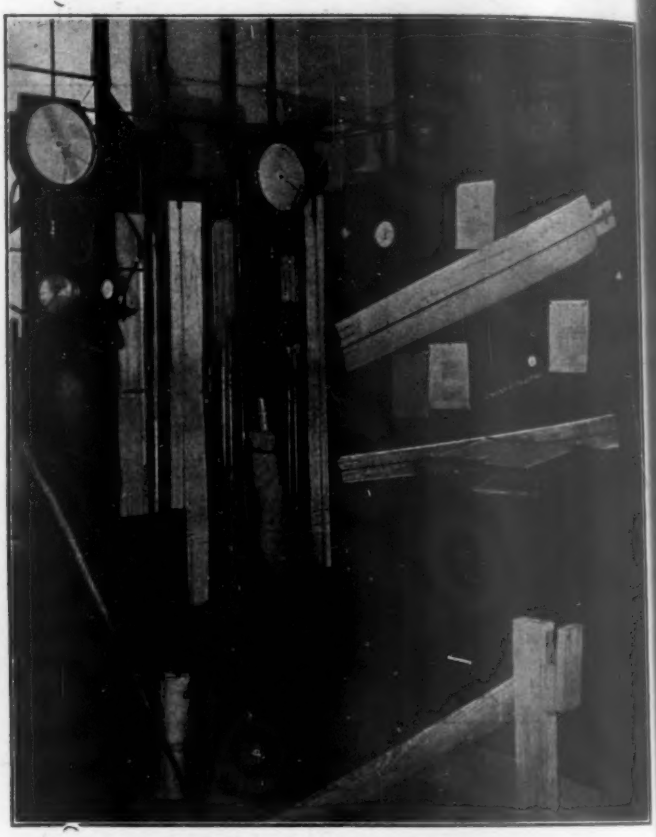


Fig. 4. Gage-Board System

a Weighing system for determining amount of gases used during tests by loss of tank weight.

b Gage-board system containing necessary pressure gages, regulators and orifice flowmeters.

c Welding table.

d Cutting table.

e Flashback and safety testing apparatus.

Figs. 1 and 2 show the entire equipment. The tanked gases are "banked" and counterpoised on an equal-arm balance. The gas from these tanks passes through a regulator *a*, thence through a flexible hose to the back of the gage board. Passing through the board the supply line enters a second regulator *b*, thence through a needle valve *c*, to the top of and through an orifice flowmeter *d*. The gas coming from the extreme bottom of the flowmeter is then conducted through a standardized length of flexible hose *e*, containing a safety flashback tank *f*, to the blowpipe to be tested.

Fig. 3 is a view of the operator's table, showing the use of mirrors for taking practically simultaneous readings of the balances. Fig. 4 shows a gage-board system. In the center of the board is one of the flowmeters, surrounded by wool-felt insulation.

Accuracy of Tests

Unusual precautions were taken to insure accuracy.

If the gas losses through leakage exceeded 0.01 to 0.02 lb. per hour, actual testing of the blowpipes was not continued until the leaks causing such losses were located and stopped.

The values obtained for gas consumption were accurate to 0.005 lb. and in most cases probably much closer.

With the precautions taken with the regulators, it was readily possible to maintain under almost all conditions a pressure varying not more than 0.01 or 0.02 lb. from the desired amount. Autographic records gave visual evidence of the absolute uniformity of the pressure under which the blowpipes were operated during the tests.

Special orific flowmeters were designed to facilitate securing

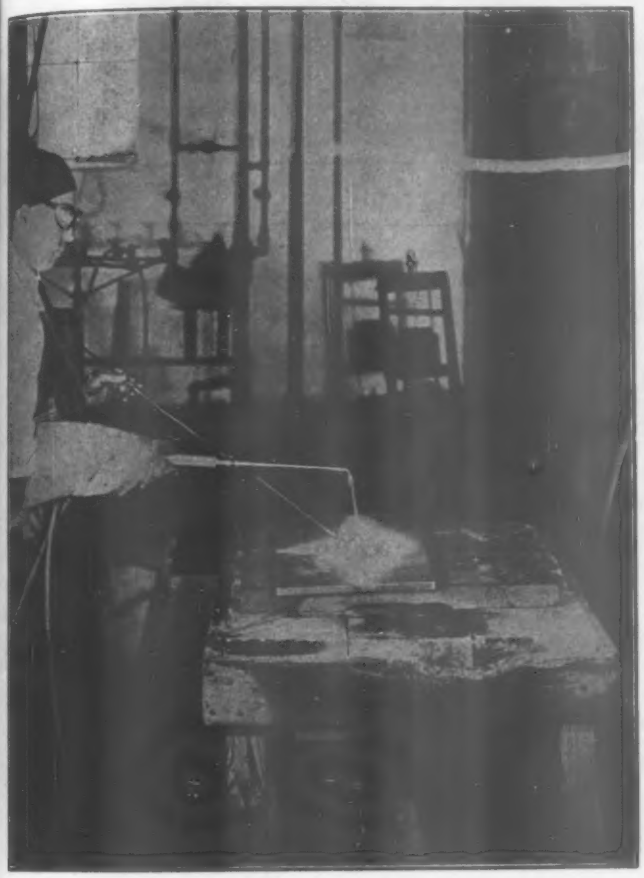


Fig. 5. Welding Table

data on continuous blowpipe action and as a check on the weighing system.

To complete the records, the gage board was equipped with a standard calibrated thermometer, a psychrometer, a barometer and a stop watch.

Elaborate precautions were taken to maintain the gas conditions constant during the tests.

The Welding Table

All welding during the tests was performed upon the welding table illustrated in Fig. 5. This was a wooden-frame table approximately three feet square, the top of which was composed of firebricks. On top of the firebricks was placed a heavy casting channelled for a width of about six inches throughout its length. This formed the base upon which all the plates for welding rested during the welding operation. The plates were aligned centrally along this base with the idea that the casting with its grooved surface would permit of better heat radiation along the line of the weld and at the same time form a baseplate or background to prevent possible inconveniences from the blowholes caused by blowing the welded material through the bottom of the V of the test weld plates.

As indicated in Fig. 5, the line of the weld was placed directly in front of the welder and the welding was perfformed from the back toward the operator, thus giving him a full view of the work as it progressed. The welded plates were cut so that the welds were 1 ft. in length. Where 2 ft. of weld were made continuously, pairs of plates were set in front of each other with a slight space between the individual pairs and with proper allowance for expansion so that the process could be carried from one plate to the other without any interruption. The groove along the baseplate facilitated the preheating of the second pair of plates, so that the start upon the second weld was made under practically the identical conditions which existed when the first pair of plates was finished, a condition that would be equivalent to that which would occur if the weld was made as one of 2-ft. length instead of two of 1 ft.

The Cutting Table.

In order to minimize as far as possible the personal equation

Fig. 6. Mechanically Operated Cutting Table

entering into cutting tests, all tests were made by a mechanically controlled cutting device installed upon the cutting table, Fig. 6 and Fig. 1. This was a wooden-frame table approximately 4 ft. by 12 ft. in size with metal-bound edges and a firebrick top. At each end of the table and securely fastened to it were 6-in. by 6-in. sticks placed crosswise, along the top of which were fastened 1-in. by 2-in. bars of metal. These latter acted as runners to carry a channel placed with flanges down as illustrated in the figures. The channel held the track upon which the mechanically controlled cutting device operated. Longitudinal motion of the blowpipe could therefore be secured by causing the machine to move along the track and lateral shifts were made by sliding the channel along the runner bars screwed to the 6-in. by 6-in. end blocks. In order to facilitate quick lateral movement of the channel and insure, where such was desired, that pieces of definite width could be cut, the runner bars had a series of holes spaced conveniently at 2 in. on centers and a set of metal pins which fitted these holes. See Fig. 1. By inserting the pins in the proper holes the channel could be instantly shoved over a definite required distance.

This compound arrangement facilitated greatly the making of continuous cuts of 10 ft. or upward. The cutting machine being fitted with a reverse-motion gear could be operated in a forward direction for the full length of the table, reversed in direction of travel and at the same time the channel slid over a definite distance and thus the blowpipe made to travel backward

WELDING AND CUTTING APPARATUS

MEN OF EXPERIENCE

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GENERAL OFFICES: 25TH AND PENN AVENUE
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"REGO"
OXY-ACETYLENE
WELDING AND CUTTING
EQUIPMENT
—
SUPPLIES

June 22, 1921

Bastian-Blessing Co.
Austin & La Salle sts.
Chicago, Ill.

Gentlemen:-

During our three years' experience in selling "Rego" welding and cutting equipment, there is just one thing that we have found wrong with the line, - "Rego" prices are too low.

There seems to be a certain element in the trade that feel that unless they pay exorbitant prices, they are not getting quality apparatus. What they fail to understand is that "Rego" is manufactured on such a large and efficient scale that the manufacturing cost is exceptionally low, and marketed under a plan which eliminates the extravagance of advertising and sales cost, carried by so many other makes of apparatus and which is necessarily included in the purchase price.

Of course, we know, as a result of many competitive tests that we have conducted against higher priced makes of apparatus on the market, that "Rego" has them "all beat" in all around efficiency, ability to stand up under severe usage, and careful workmanship and material.

Despite the low price of "Rego" we have been able to convince a considerable number of the large Steel companies in our vicinity, that quality and reasonable prices can be applied to the same article, and that they have been combined in "Rego" We have convinced these people to the point of receiving their orders - regularly.

Yours very truly,

WELDCRAFT EQUIPMENT COMPANY

Frank A. Boyer.

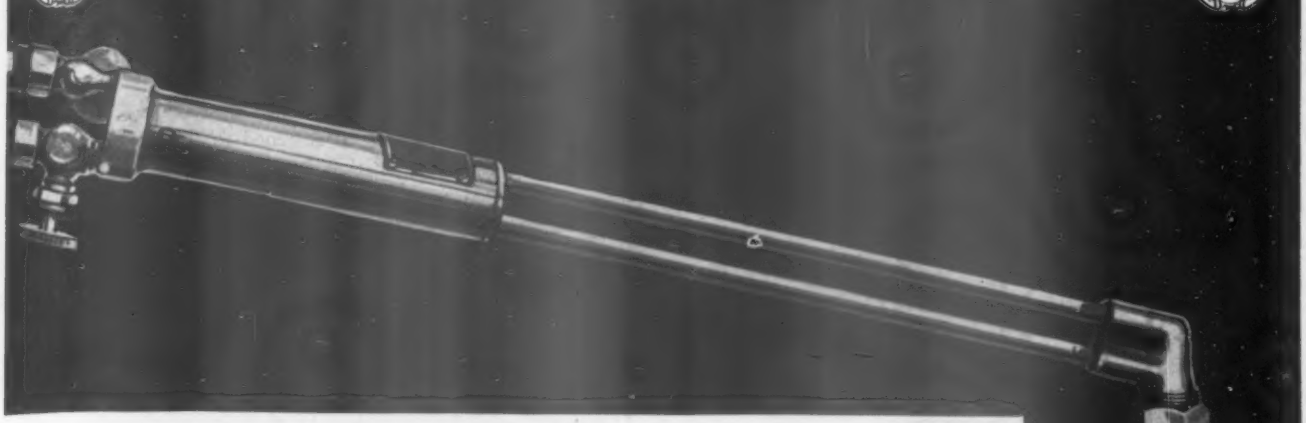
Manager.

FAB:RL

P.S. Please note we have just opened a new Rego station at Philadelphia.

THE BASTIAN BLESSING COMPANY
WEST AUSTIN AVENUE AT LA SALLE STREET CHICAGO.

WELDING AND CUTTING APPARATUS



"There Is Just One Thing Wrong with Rego"

says Frank A. Boyer, another man of experience in the welding and cutting industry,

"The Prices Are Too Low"

If you are a part of the "certain element in the trade" who believe that you have to pay a fancy price for quality, you had better arrange to have a "Rego man of experience" show you Rego apparatus.

Send for Rego Catalog No. 23
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containing revised price list and description of additions to the line. We will be glad to send you the name of the nearest Rego distributor.

THE BASTIAN BLESSING COMPANY
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for the full length of the table for a cut on a new and adjacent line.

In order to furnish room for the disposition of the slag formed during the cutting operation, the metal to be cut was supported on a system of teeth as shown in Fig. 6. These teeth proved extremely satisfactory and made a very convenient method of maintaining metal in proper position for cutting.

The Flashback and Safety Apparatus

Flashback-Protection Tanks. The testing equipment also included in the gas lines two flashback tanks (*f*, *Fig.* 2, and *Fig.* 1). These tanks were essentially hydraulically controlled valves which were intended to prevent the propagation of an explosion in the blowpipe or gas line backward toward the gas supply. They are shown in sectional view on Fig. 7. While it was generally realized that the installation of the water seal of these flash-protection tanks might be considered detrimental, due to the absorption of moisture by the gas, it became evident that their installation was nevertheless a prime necessity as a means of protecting the rather expensive gage-board equipment. It was believed, further, that, inasmuch as the oxygen in use generally came from cylinders that contained more or less water, the passing of the gas through the hydraulic seal of the flash-protection tanks would in reality tend to standardize the moisture content in the gas and therefore produce similar effects for all blowpipes.

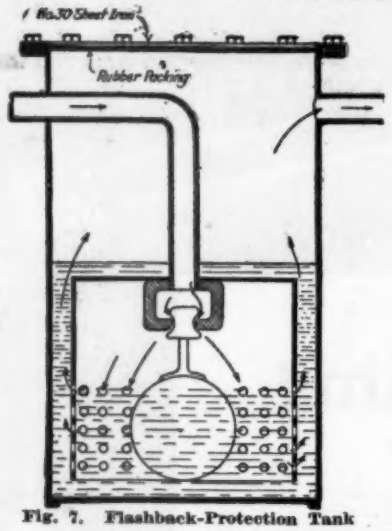
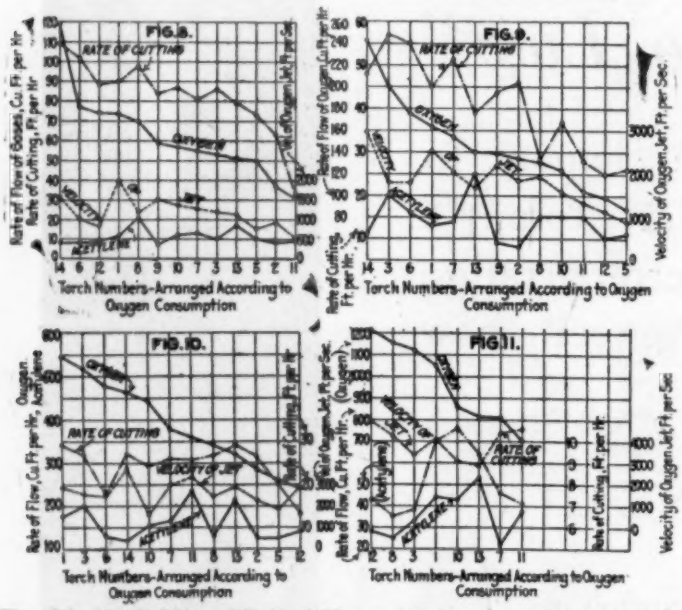


Fig. 7. Flashback-Protection Tank



Figs. 8 to 11. Relation of Rate of Flow and Velocity of Exit of Oxygen to Rate of Cutting Metal
(Fig. 8, for ½-in. metal; Fig. 9, for 2-in. metal; Fig. 10, for 6-in. metal; Fig. 11, for 10-in. metal.)

These flash-protection tanks proved extremely satisfactory for the purpose intended, in that in several explosions they prevented the propagation of the flame beyond the flash tank. They generally ruptured by the blowing off of the head of the tank during the explosion. As furnished the heads were of rather thick sheet metal, fastened on with bolts as indicated on Fig. 7. This construction proved to be somewhat dangerous to the operators making the tests and the tanks were therefore modified in their construction, as indicated in the figure, by having a rubber packing and a thin sheet of metal fastened to the top with a heavy annulus. By this construction it was expected that if an explosion developed within the flash tank, the thin metal sheet would rupture by tearing and thus minimize danger from flying parts.

Flashback Apparatus. The tests for freedom from flashback and safety in operation were conducted with the so-called flashback apparatus. For this series of tests a pair of flash tanks were connected into the hose lines immediately back of the blowpipe. Between the flash tanks and the blowpipe proper two observation boxes were installed. These observation boxes consisted of a glass observation tube inserted in the gas lines and protected by a glass-covered observation box. The box was of wooden side and back construction with a vented back and a duplex glass face. The interior of the observation box was painted dead black to facilitate observation of the flame propagation. This equipment was used throughout the entire series of flashback tests and for the severe flashback test mentioned later.

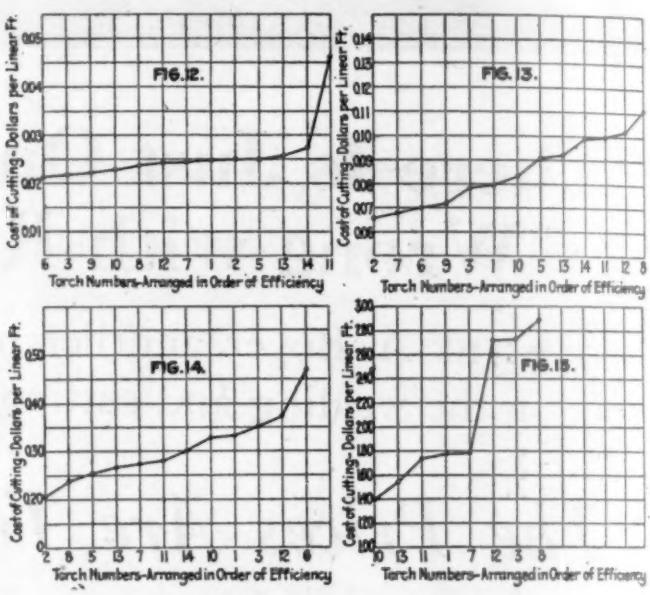


FIG.12.
Cost of Cutting-Dollars per Linear Ft.
Torch Numbers-Arranged in Order of Efficiency
FIG.13.
Cost of Cutting-Dollars per Linear Ft.
Torch Numbers-Arranged in Order of Efficiency
FIG.14.
Cost of Cutting-Dollars per Linear Ft.
Torch Numbers-Arranged in Order of Efficiency
FIG.15.
Cost of Cutting-Dollars per Linear Ft.
Torch Numbers-Arranged in Order of Efficiency

Figs. 12 to 15. Cost of Cutting Metal, Per Linear Foot, with Oxy-Acetylene Blowpipes
(Fig. 12, for ½-in. metal; Fig. 13, for 2-in. metal; Fig. 14, for 6-in. metal; Fig. 15, for 10-in. metal.)

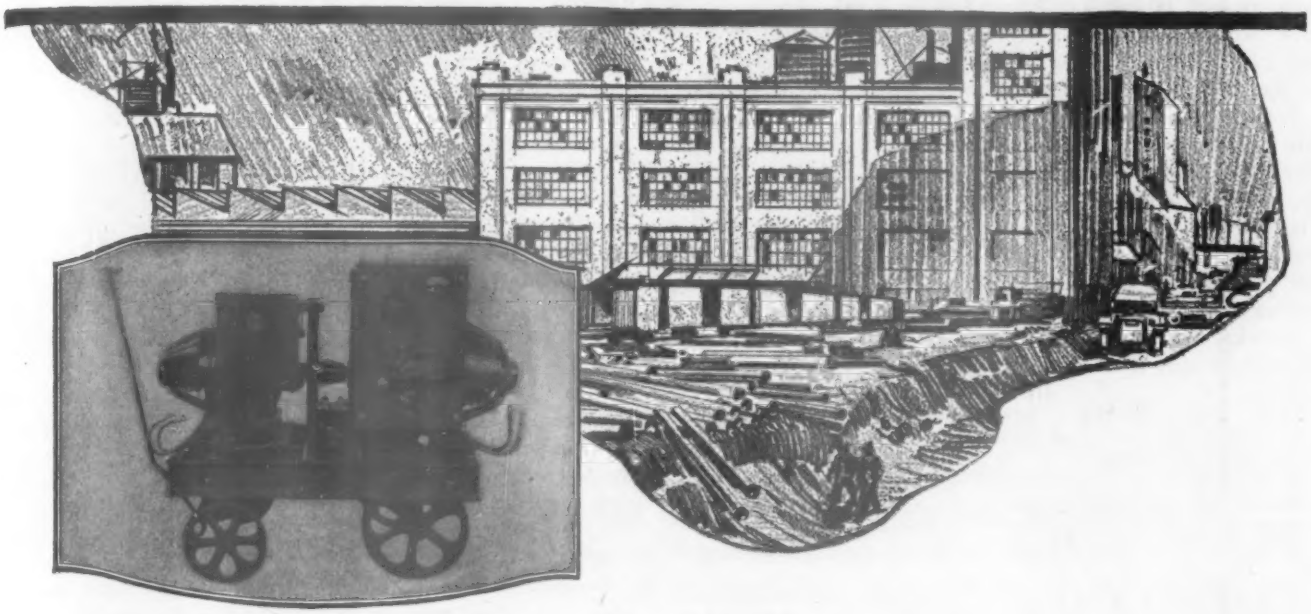
Materials Used in Tests

Welding Rod. The welding rod used throughout the entire series of tests was secured from the Naval Gun Factory, Navy Yard, Washington, D. C. This rod was purchased in July, 1917, under Navy Department Specification 22-W-4. A number of chemical analyses were made and the percentage composition was found to be as follows:

Carbon	0.024 to 0.03	Silicon	0.002 to 0.004
Manganese	0.05 to 0.08	Chromium	Trace
Phosphorus	0.01 to 0.015	Nickel	Not detected qualitatively
Sulphur	0.023 to 0.024	Vanadium	Not detected qualitatively

Steel Plates for Welding and Cutting. The steel plates used for welding were ½ in. and ¾ in. in thickness. The material used for cutting was ½, 2, 6 and 10 in. in thickness. All the material used in both welding and cutting, except the 10-in., was furnished through the Engineer Corps, War Department,

The activities of wartime industry proved beyond a doubt that the electric arc had been underestimated as a peace-time asset



Is There a Place in My Factory for Electric Arc Welding?

To answer this question, a manufacturer must ask himself three more:

"Can my product be improved or my production speeded up by this process?'
"Am I losing money through defective work which might be reclaimed by electric arc welding?"
"Does the repair work in my plant offer a profitable use of electric arc welding?"

If the obvious answer to any one of these is "yes," it is time for that manufacturer to investigate the possibilities of electric arc welding and learn what this remarkable science is doing in a wide variety of industries. He will discover that in shipbuilding, railroad shops, boiler shops, pipe mills, and hundreds of other plants where metal parts are permanently joined together, electric arc welding equipment is the answer to like questions—and many others.

To enable the manufacturer, who doubts the advantages of using electric arc welding in his own factory, to see for himself the possibilities of this process, the General Electric Company has made a thorough study of its various uses, and has built definite types of welding equipment to take care of almost every kind of work. This equipment is now available for prompt delivery.

Select the right equipment for the work—and a welder who knows his business

Bulletins describing G-E Welding Equipment and the G-E Welding School sent on request to our nearest office

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and was selected with special reference to uniform quality for any particular thickness. The ½-in. material was furnished in plates 3 ft. by 5 ft. in size and was used for both welding and cutting tests. The middle section of each plate was retained as a sample for determining the qualities of the plate. The remaining pieces were used for making welds. During the welding tests it was the practice to use plates that were adjacent to each other in the main or full plate before it was cut into weld speciments, so that as nearly as possible the material used for any particular test would be identical.

The ¾-in. material for welds was received in plates 12 in. wide by 6 ft. in length. These plates were cut up into sections 9 in. in length, and for the full width of the plate, that is, 12 in. All specimens for welding tests were finished with a butt joint of the single V 90-deg. included angle type.

For the cutting tests the 3-ft. by 5-ft. by ½-in. plates were cut into strips approximately 1½ to 2 in. in width as indicated in the description of the cutting apparatus above. The 2-in. material for cutting was furnished in sections 2 in. by 6 in. by 20 ft. These were cut, for convenience in handling, into 5-ft. lengths and in test operations cut lengthwise into sections of 2 in. width. The 6-in. material was shell billet steel furnished in 3-ft. lengths and was cut lengthwise in test operations.

Chemical analyses of these materials indicated that they were of approximately the following percentage compositions:

½-in. mild-steel plate for welding and cutting tests:	
Carbon	0.14
Manganese	0.32 to 0.36
Phosphorus	0.012 to 0.013
Sulphur	0.033 to 0.055
Silicon	0.006 to 0.012

¾-in. plate for welding tests:	
Carbon	0.25 to 0.27
Phosphorus	0.011 to 0.013
Sulphur	0.041
Silicon	0.004

2-in. mild steel for cutting tests:	
Carbon	0.19 to 0.20
Manganese	0.42 to 0.44
Phosphorus	0.025 to 0.027
Sulphur	0.055
Silicon	0.009 to 0.017

6-in. steel for cutting tests:	
Carbon	0.46 to 0.51
Manganese	0.60
Phosphorus	0.029 to 0.038
Sulphur	0.064 to 0.067
Silicon	0.13 to 0.14

For extra heavy cutting it was desired to determine what the various blowipes could do on special material approximating armor plate in quality. For this purpose the Naval Gun Factory supplied a cast-steel billet 10 in. by 36 in. by 50 in. in dimensions. This proved to be of the following percentage chemical anlyses:

Carbon	0.38	Silicon	0.25 to 0.28
Manganese	1.21 to 1.28	Copper	0.96
Phosphorus	0.038 to 0.043	Nickel	2.62 to 2.70
Sulphur	0.019 to 0.027	Chromium	Less than 0.01

Description of the Tests

The tests were started with the idea of submitting each manufacturer's equipment to the series of tests listed in a circular sent out under date of February 18, 1920. It was found, however, that the proposed series of tests was excessive from the time standpoint. One of the most serious drawbacks as a time-consuming element was the fact that a very large percentage of the blowpipes submitted for test would not operate with the pressures specified by the manufacturers. This condition was probably due to the fact that it is quite a customary practice to recommend setting the regulator pressures three to five pounds higher than the specified blowpipe pressures. By throttling the gases at the blowpipe-handle valves the operator insures having sufficient pressure available at all times to maintain the required velocity of exit of the gases at the tip end. He is therefore enabled to compensate for pressure fluctuations due to irregular action of the regulator, thus tending to minimize the development of flashbacks. The specifications for the tests distinctly stated that at least one of the blowpipe-handle valves must be maintained at full opening during a test. It was only by such a procedure that the gas consumption of a blowpipe could be definitely ascertained. For a great many of the blowpipes the pressures were too high to enable the maintenance of a stable flame with one of the handle valves at full opening.

Another quite serious source of trouble from the standpoint of time consumption was that due to leakage, necessitating the dismantling and repacking of valves.

In order, therefore, that the entire investigation might not require an undue length of time it was decided that attention should be devoted only to the so-called primary tests, consisting of the welding, cutting, gas-ratio, and flashback tests. Such proposed tests as the variation of pressure within the blowpipe head, etc., were therefore abandoned. On the basis of the foregoing the following schedule of tests was adopted and all blowpipes tested during this investigation were submitted to them.

Welding Tests. All blowpipes reported upon were submitted to five welding tests, designated respectively as Tests 1*a*, 1*b*, 1*c*, 1*d*, and 2. All the tests numbered 1 were made with ½-in. plate. Test 2 was a weld with ¾-in. plate.

Tests 1*a* and 1*b* were made with the tip sizes and pressures specified by the manufacturer if this were possible. For both of these tests a 2-ft. length of weld was made. These tests were identical in all respects, with the exception that an attempt was made to evaluate the personal equation by using different operators. For Tests 1*c* and 1*d* a 12-in. length of weld was made. Both of these welds were made by the operator who made the weld of Test 1*a*, the idea being to maintain as nearly constant a personal equation for this series of tests as possible. Test 1*c* was run with the same size of tip as 1*a*, but with pressures (both oxygen and acetylene) 50 per cent in excess of the pressures used for Test 1*a*. Test 1*d* was carried out similarly to 1*c*, except that the pressures were 25 per cent below those used in Test 1*a*.

As mentioned above, the pressures specified by the manufacturer very often gave an exit velocity to the gas too high to permit of maintaining a stable flame at the blowpipe tip. In such cases the manufacturer's representative was requested to furnish a modified pressure that would enable the maintenance of a stable welding flame. Very often the modified pressure thus determined upon would not permit of the application of Test 1*c*, that is, a test with a 50 per cent increase in pressure in both gas lines. It was customary, therefore, in such cases to modify the test procedure and incorporate as a test in place of Test 1*c*, Test 1*e*, which was run under identical conditions with the above test, with the exception that the pressure on both gas lines was reduced to 50 per cent of the pressure used to make Test 1*a*.

Tests 1*c*, 1*d*, and 1*e* were incorporated to show the effects of increased or decreased pressures on the operation and economy of the blowpipe. Such excess or decreased pressures are found to be quite common in many welding operations, due to carelessness on the part of the operator in setting regulator pressures or to imperfect regulator action. It was felt that a properly designed blowpipe should be capable of adjustment over a considerable range for any specified tip size. It was hoped in the investigation to secure data that would either verify this assumption or prove that it was absolutely essential to maintain exact pressures for satisfactory blowpipe operation.

Test 2 was a 12-in. length of weld of ¾-in. mild-steel plate. This weld was made in all cases by the operator who made the weld of Test 1*b*. This test was selected as indicating the probable results to be obtained with a blowpipe in heavy welding, and with Test 1 it was felt that it would give a fair idea of the adaptability of the blowpipe for welding purposes. The tips for welding ½ and ¾-in. plate were selected as being the tips used respectively for the average-size weld and for the maximum-size weld, and therefore the best general average for determining the blowpipe's efficiency and safety.

Cutting Tests. The cutting blowpipes reported upon have been submitted to eight cutting tests, four of which may be con-

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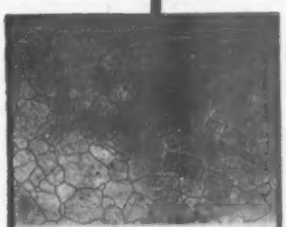

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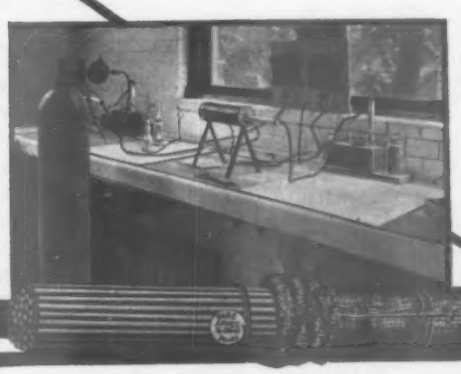

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sidered primary. In each of the cutting tests a length of cut was made that was sufficient to determine accurately the gas consumption of the blowpipe . Test 6*a* consisted of cutting continuously 50 linear feet of ½-in. mild steel, Test 7 was a continuous cut of 10 ft. of 3-in. mild steel, Test 8 a continuous cut of 6 ft. of 6-in. medium steel, and Test 9 a cut by hand for maximum thickness.

Each test cut was preceded by a preliminary trial cut to determine the maximum speed at which the blowpipe would cut with the tip size and pressures specified by the manufacturer for the particular thickness of metal. It was found during these trial cuts that the same condition existed relatively to the cutting blowpipes that was found to exist with the welding blowpipes, that is, that a great many of the pressures specified by the manufacturers for cutting particular thicknesses of metal were not suitable for the work intended. One of the main troubles seemed to be that the majority of the blowpipes were operated with preheating flames of too high intensity.

Throughout the entire series of cutting tests all blowpipes were operated similarly, that is, at least one of the gas-control valves for the preheating flames was at full opening, the preheating flames were adjusted to neutral with the oxygen cutting valve at full opening, and all cutting operations were started with this latter open. Some criticism of this procedure developed from time to time, but throughout the entire series of tests it was found that at no time were any detrimental results produced, and that even on cuts as heavy as 16 in. no trouble was found in starting with the oxygen cutting valve open. This method was adopted to insure the maximum capacity of the blowpipe throughout the entire test period, and further to enable the maintenance of accurate pressures throughout the test and insure accurate data as to the maximum gas consumption during the cutting operation.

Test 9, cutting for maximum thickness, was orginally conducted with the idea of submitting the blowpipe to a test for the maximum thickness specified by the manufacturer as permissible for his blowpipe. It was found during the course of the investigation that the great majority of the blowpipes would not successfully cut the so-called maximum thickness specified by the manufacturers and published in their literature. Experience during the investigation seemed to indicate that the probable maximum commercial limit for economic heavy-cutting operations when the cut is made in one direction only with an ordinary stock blowpipe, lay in the neighborhood of 10 in. It was therefore decided that all blowpipes should be submitted to the same maximum or heavy cut. A cut in material 10 in. in thickness and 12 to 18 in. in length was therefore made as a supplementary heavy-cut test for each blowpipe.

The tests for maximum thickness of cut were made by hand. On account of the possibility of damage to the gage-board equipment caused by heavy slag showers from pockets, etc., produced during cutting, this test was conducted out of doors. The original tests for maximum thickness were therefore made on different days, with the temperature of the metal varying from 35 to 68 deg. After the decision had been made to submit all blowpipes to cutting tests of identical thickness, it was decided to minimize the effects of varying temperature as much as possible on the heavy cut by making all cuts during the course of one or two days. By this procedure only a slight temperature change occurred. Particular care was also exercised to insure that a blowpipe was not submitted to test on pieces of the steel ingot used for this work that were still warm from a test of another blowpipe. The test for heavy cutting, that is, the special 10-in. cut just described, is listed in the data that follow as Test 9.

Besides the primary tests it was thought desirable also to determine the efficiency of the blowpipe as it was affected by variations in the oxygen pressure supplied. For this purpose a series of supplementary tests listed as Tests 6*b*, 6*c*, 6*d*, and 6*e* were conducted. These were made on ½-in. mild-steel plate and a cut of 10 linear feet made for each test. In this entire series of tests the tip sizes and the conditions of cutting were identical with Test 6*a* listed above, with the exception that the oxygen pressures alone were modified. These were increased 50 and 25 per cent and decreased 25 and 50 per cent, respectively, for Tests 6*b*, 6*c*, 6*d* and 6*e*. No change was made in the acetylene pressure. A slight aspirating effect for the increased oxygen pressure was expected and was shown in the volume of the acetylene used.

Gas-Ratio Tests. One of the prime essentials of a good welding blowpipe is its so-called gas ratio, that is, the ratio of the volume of oxygen to the volume of acetylene consumed. Theoretically a properly adjusted blowpipe requires equal volumes of both gases, giving the ratio of 1 to 1. In order to establish the ratios of the blowpipes under test, each one reported upon was submitted to a series of gas-ratio tests, numbered 5*a*1 and 5*b*.

For these tests the blowpipe was allowed to burn freely in air with the same tip sizes and pressures as were used in the welding tests mentioned above. The blowpipe was supported upon a bracket stand with the tip in horizontal position. All gas-ratio tests were made upon the tips used for welding and no attempt was made to clean them before making the tests other than to blow them out with a rather high oxygen pressure. These tests might be expected to indicate the gas consumption of the blowpipe with the flame burning undisturbed from accidental obstructions, such as slag adhesions to the ends of the tips, etc., which occur in actual welding practice. The discussion of the welding blowpipe furnishes additional interesting information concerning the gas-ratio tests.

Flashback Tests. In order to determine the probable safety of operation of a welding blowpipe and, further, to secure information concerning the permanency of construction of the tip and blowpipe head, the blowpipes reported upon were submitted to two types of flashbacks tests.

One series of tests designated 3*a* and 3*b*, flashback tests on the tips used for welding ½-in. metal and ¾-in. metal, respectively, consisted of the standard series of tests used by the Underwriters' Laboratories for determining the freedom from flashback and the safety of the welding blowpipe. Each of these tests consisted of four distinct operations. The first three of these operations were carried out as follows: After being properly adjusted to neutral flame the blowpipe was tested for flashback by drawing the tip at varying angles across the surface of, and finally pressing the tip end firmly against, certain materials. For this test a cold steel plate, a firebrick, and a piece of wood were used. Finally the tip was used to make a pool of molten metal in a cast-iron block, flux being used to assist in maintaining the fluid condition of the metal and the tip suddenly plunged into the pool of metal.

Another series of tests intended to determine the permanency of construction and designated as the Severe Flashback Test, Test 4, was carried out by supporting the blowpipe on a vertical sliding carriage in such a manner that at the proper instant the ignited and carefully adjusted blowpipe could be lowered so that the end of the tip was directly over the center of a hole 2 in. in diameter and 2 in. deep, drilled in a heavy cast-iron block.

In all the flashback tests the blowpipe was operated under the identical conditions at which it was supposed to be used during the welding operations, and after the initial adjustment of the flame no further adjustments were permitted. Following also the procedure in the welding tests, at least one of the blowpipe-handle valves controlling the gas had to be at full opening.

Log-Sheet Records of Tests. It has not been thought advisable, in the light of the discussions following, to incorporate as parts of the report the test log sheets, especially as there are over 1900 of them.

Discussion of Test Results

General Basis of Consideration. Summaries giving the results obtained with the various blowpipes, and upon which the follow-

ing discussion of test results is based, are included in curves of Fig. 8 to 15.

57. For convenience in analysis, the results of these tests are summarized in a series of plotted graphs. In the plotted summaries are shown the results of tests on blowpipes from fourteen different manufacturers, each represented by a designating number. The groups submitted to test comprises most of the better-known and more widely advertised makes of apparatus on the American market and includes, besides those voluntarily submitted, three makes of apparatus that were withdrawn by their manufacturers because of disagreement over methods of test procedure. Samples of these latter three were purchased for test purposes.

62. The Cutting Blowpipe. The summaries of the data obtained from cutting tests made with the various blowpipes are shown in Figs. 8 to 15. The study of these data shows some rather interesting conditions relative to the art of metal cutting by the oxy-acetylene process, as follows:

a The very great irregularity in the shape of the graphs indicates quite clearly that if the individual blowpipes have been designed acccording to a theory, there does not exist any generally accepted theory. In cutting identical material under standardized conditions the various blowpipes exhibit, as indicated by the data for cutting ½-in. metal, variations in speed of cutting of 330 per cent; variations in volume of oxygen consumed per hour of 430 per cent; variations in velocity of exit of cutting-jet oxygen of 390 per cent, and variations in volume of acetylene consumed of 300 per cent.

b In general the speed of cutting increases with the volume of oxygen consumed, provided the velocity of exit of the cutting jet and the amount of acetylene consumed in the preheating flame are kept constant.

c With the same velocity of exit of cutting jet and equal oxygen consumption the speed of cutting is reduced and therefore the cost of operation increased by an increase in the amount of acetylene consumed in the preheating flames, the increased amount of acetylene requiring a larger amount of oxygen for its combustion and thus decreasing that available as an oxidizing agent in the cutting jet.

d With equal acetylene consumption and equal oxygen consumption the rate of cutting, and therefore the decrease in cost of operation within limits, increases with the velocity of exit of the oxygen cutting jet.

e With equal acetylene consumption, increasing the velocity of exit of the oxygen jet and at the same time the oxygen consumption does not necessarily increase the speed of cutting in commensurate ratio, and may even tend toward increased cost of operation. It seems apparent that there is an economical limit to such increases and that with too high a velocity an increased oxygen volume may be wasted. This indicates that for any thickness of metal there is a limiting velocity at which complete utilization of the oxygen takes place and a limiting value to the amount of oxygen required to produce the cut.

As indicated above, there is a great deal of difference between the characteristics of blowpipes of different designs. One of the most interesting and noticeable differences is the fact that no make is equally proficient and economical for all thicknesses of metal. Of the six most economical cutting blowpipes on ½-in. material, two failed to cut 10-in. material and the remainder stand almost in the inverse order of rating. Further, two of the most uneconomical blowpipes on ½-in. material are two of the most economical on the heavy or 10-in. cutting. It is interesting to note that this reversal of performance in general seems to be progressive with the variation in thickness of metal cut. (See Figs. 12 to 15.)

The reason for reversal of performance, upon examination of the data available, seems to be quite clearly indicated. The average design of blowpipe is operated with the oxygen jet issuing from the tip at too great a velocity. It will be noted that the most efficient blowpipes are those operating at the lower velocities for the metal of various thicknesses. Where there appears to be a divergence from this fact, it will be further noted that these blowpipes seeming in performance to be inconsistent with the above statement are those using an excessive amount of acetylene.

A portion of the data plotted to show the relation between area of metal cut per cubic foot of oxygen consumed for the various thicknesses is of further interest, as it suggests that none of the blowpipes submitted to test is as economical in cutting 2-in., and possibly 10-in., metal as might be expected.

The law governing the relation between the area of metal cut per cubic foot of oxygen consumed for various thicknesses has not been determined during this investigation. The data indicate that very probably a straight-line relation exists, in which case the tests would show further that there is a definite limit to the thickness (about 12 in.) which can be cut by the oxy-acetylene process.

On the basis of the straight-line relation it is very evident that none of the blowpipes tested was cutting 2-in. material economically. It would seem that the reason for this non-economy of operation is probably due to two things: First, the use of an oxygen cutting jet issuing at too great a velocity. If a velocity of 2,200 ft. per sec. is sufficient for cutting 6-in. material, it would appear that a velocity of 1,800 ft. per sec. is excessive for 2-in. plate and that used for the 6-in. material. For the thinner flames in most cases were too large for the work required. In fact, in a number of instances there was practically very little difference between the size of the preheating flame used for the 2-in. material. Secondly, in the blowpipes tested the preheating material the large-sized preheating flame would tend toward non-economy in operation, inasmuch as it would preheat a relatively large surface with the resulting tendency for the oxygen to oxidize the entire body of metal thus preheated, giving probably a wider kerf than necessary and thus using the oxygen supply non-advantageously. This conclusion is further substantiated by the fact that in cutting 2-in. material practically none of the slags showed metallic characteristics, but was on the other hand fully oxidized metal.

A further study of the data indicated also that possibly the maximum economy has not been fully secured for the 10-in. material. The cuts for this thickness also indicate that the maximum limit for economical cutting was being approached.

In questions of economy of operation the volume of gas used plays an important part. Where an excessive amount of acetylene is used, acetylene being the more expensive gas, the economy of operation is affected adversely. This question of acetylene consumption is one that would seem to deserve attention. The size of the preheating flame is a direct index of the acetylene consumption. As indicated above, in a great many of the blowpipes tested it was found necessary to reduce the acetylene pressure under that specified by the manufacturer (thereby reducing the size of the flame or acetylene consumption) in order to secure the flame size that did not melt too much of the top edge of the cut and reunite the pieces cut apart by the flow of this molten metal back into the kerf. In some instances with the specified preheating flame the pieces were practically welded together again along the top edge, and in others the top edge was badly beveled.

Neither of the above conditions, developed by excessive-sized preheating flames, is desirable. Even though not welded together, a badly beaded top edge or a badly beveled top edge would increase the cost of following manufacturing operations in most cases. The feeling of the blowpipe manufacturers on this matter seems to be that they must have excessive pre-

(Continued on page 42.)

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The Human Element Remains

IN various comments that have been made on Mr. Johnston's paper considerable emphasis has been placed on objections to operating hand torches by mechanical devices for the sake of eliminating the factor of the operator's skill. The point seems to be very well taken, for in addition to the reasons advanced there is the fact that no welding operation is altogether foolproof. Even the butt and spot welding that is accomplished by resistance welding machinery, the theoretical operation of which is supposed to consist of merely pulling a lever, is dependent upon some degree of attention and care to secure maximum efficiency. A piece-work operator, for example, will turn out vastly inferior work if he attempts to increase his output by rushing his work, or by careless preparation of material. Cutting is likewise economical according to the proficiency of the cutter, so it is well to take into account in an investigation of this sort the fact that the individual who handles the apparatus has a good deal to do with the results.

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EVERY job welder should be a consulting engineer on the subject of welding for his trade. The best way to keep the customer's confidence lies in being able to discuss welding problems intelligently, and with authority. To this end his advertising should always carry an offer of competent advisory service, accompanied by bits of general information on welding which are not generally known. Let people know why your welding is dependable, why they ought to entrust welding problems only to men who are doing welding every day of their lives, and why the ordinary mechanic cannot take the place of the expert welder. The intense heat of the oxy-acetylene flame and the electric arc and the necssity for long practice in handling it are subjects that will interest prospective customers. If they feel that you know exactly what your welder is going to do and exactly why he is going to do it they are all the more ready to send their work to your shop.

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Who's Who

D. RICHARDSON

David Richardson, Captain, Royal Air Force, is the editor of the Acetylene and Welding Journal, London, England. Captain Richardson secured his engineering training by serving as apprentice engineer for the London and Northwestern Railway Co., from 1895 to 1902, and as draughtsman and test engineer for the Premier Railroad Company of Great Britain from 1902 to 1904. He also took the engineering course at Manchester University during the last four years of his work with the L. & N. W. Ry. Co., and secured metallography training at the Imperial College of Technology, London. From 1905 to 1915 he was chief assistant in Engineering and Mathematics at Northern Polytechnic College, London.

Capt. D. Richardson

In 1912 the Northern Polytechnic commenced the first training courses in Great Britain. Captain Richardson attended a course at the Maschinenbauschule zu Cologne under Theodore Kautny, visited the principal welding establishments in Germany, and organized day and evening courses in oxy-acetylene welding at Northern Polytechnic. Three years later he was busy organizing the training and taking charge of the instruction in the Royal Flying Corps, acting as chief instructor with the rank of Captain, Royal Air Force. He designed and equipped training shops for air force mechanics, to train 300 men at a time, tested welding equipment and materials for the Royal Air Force, and served as a member of the Air Board of Specifications Committee, drafting specifications for fluxes and filling materials for use in the Air Force, and as a member of the Engineering Standards Sub-Committee dealing with filling materials.

In addition to his activities in giving aid to the military, Captain Richardson is a member of the council and technical expert to the British Acetylene Welding Association, an associate member of the Institution of Mechanical Engineers, and member of the Union de la Soudre Autogene. He serves as lecturer in welding to the Ministry of Munitions and to the Northampton Engineering College, London. He is editor of the Acetylene and Welding Journal, and of the welding section of Kempe's Engineers Year Book, and besides translating into English Granjon and Rosemberg's "Autogenous Welding" is the author of books on Autogenous Welding, Cutting Iron and Steel with Oxygen, Welding of Lead, Defective Oxy-Acetylene Welds, Welding of Copper Brasses and Bronzes, Filling Materials for Welding, etc. He is a specialist in equipment and testing materials and equipment, and acts as air ministry expert in litigation on welding.

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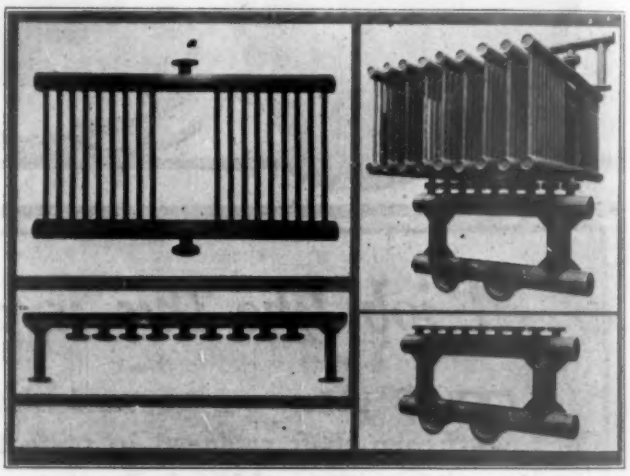
The strides that are being made in the use of oxy-acetylene welding for the fabrication of the more or less intricate equipment now being specially constructed to design and specification for oil refineries, are conspicuous. Work that was once done almost entirely by the use of threaded connections is yielding more and more to the oil-tight and gas-tight welded joint, not alone because of the demonstrated superiority of welding in this particular respect, but also because piping of the same weight is materially stronger when properly welded than when threads have to be cut for the screwed joints.

An interesting example of the application of gas welding



Mechanism of the Stills

in this field is afforded in a recent order of 40 air condenser pressure stills for one of the Standard Oil Company's refineries. The work is being done by the M. J. Daugherty Company, of Philadelphia, to whom acknowledgment is made for the accompanying illustrations and data.

The pictures give an excellent idea of the mechanism of the stills, showing the complete unit assembled, and top and bottom manifolds and one of the nine "harps" of which the unit consists. Every part, including flanges, couplings, headers and reinforcements, is welded. Eight welders were assigned to the work.

Every unit in the assembly presented a special problem. Each neck on the welded headers had to be centered accurately, only a small tolerance being permitted, as the harps had to be so joined as to give absolutely tight and leak-proof connections and conform strictly to specification and design.

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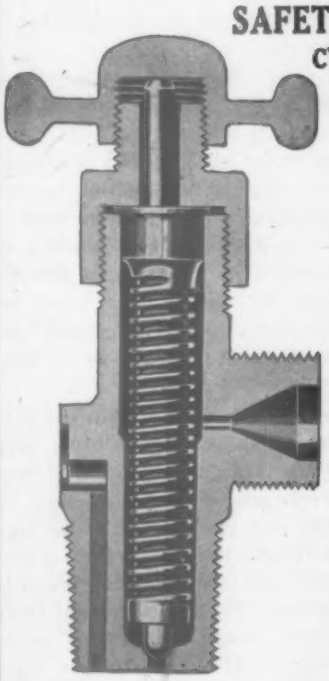

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AN INVESTIGATION OF OXY-ACETYLENE CUTTING AND WELDING BLOWPIPES

(Continued from page 37.)

heating flames to take care of heavy scale, slag, etc., and to facilitate rapid cutting, especially at the start of a cutting operation. The experience of this investigation as developed on cutting does not indicate that a cut can be started any quicker with an excessive flame than with one of proper size. In cases where slag or heavy scale are met with it is doubted whether burning slag and scale off at an oxygen cost of $1.50 to $10.00 an hour (according to thickness of material cut) can economically compete with unskilled hand labor (chisel and hammer) at 75 cents per hour.

Besides the top edge and face of a cut, the bottom edge is of interest as its appearance is quite closely connected with the type of slag formed. A completely oxidized slag has a greater tendency to cling to the under side, and if excess oxygen is present there is considerable undercutting which tends to increase the amount of slag and to make it adhere more firmly, with the result that a rough bottom edge is produced. By the proper proportioning of the oxygen volume it is apparent that a slightly metallic slag can be secured, the metallic element being due to the fact that in the presence of an insufficient oxygen volume some of the metal is blown out without being oxidized. A slightly metallic slag clings quite firmly to the bottom edge of the cut, but apparently possesses an advantage in that it may be removed in long pieces and leaves behind it, as seen, a very smooth, sharp under edge.

From this study it may be concluded that the appearance of the surface layer of the steel directly after cutting with the oxy-acetylene flame is due to the chilling action of the large mass of unheated metal upon the hot surface after the flame has been removed. Such an effect would, of course, be more noticeable in a steel of higher carbon content than in one which is lower in this element. This of course accounts for the hard surface metal that is frequently encountered in working up metal cut with the oxy-acetylene blowpipe.

The Welding Blowpipe. It is universally accepted that outside of the mechanical features of design that affect weight, balance and convenience of operation, the prime essentials of a strictly satisfactory piece of apparatus are:

a Safety under all operating conditions.

b Freedom from the so-called phenomenon of "flashback" or sustained backfire.

c The quality of maintaining under all operating conditions a welding flame that is neither oxidizing nor carbonizing one technically known as a "neutral flame," which in the process of combustion consumes, as nearly as possible, equal volumes of oxygen and acetylene; that is, maintains as nearly as possible the theoretical gas-volume ratio of unity.

The tests of this investigation were decided upon with the idea of furnishing data that would enable blowpipes to be compared with respect to these essentials.

81. A study of the data obtained at the completion of the prescribed tests showed so many apparent inconsistencies that it was evident that there was a governing factor that was not understood, and that was, so far as test data were available, not in evidence. Irrespective of the fact that particular attention had been given to insure identical working conditions and gas-pressure control, and that especial care was taken to secure exceedingly competent and unbiased operators, the results obtained from the welding tests seemed extremely unsatisfactory. Gas ratios obtained during actual welding operations were extremely high. Those obtained when the blowpipe was burning freely in air were also higher than was to be expected. In tests for flashbacks there seemed to be a difference in the ease with which they could be developed in blowpipes of different manufacture, but there appeared to be no criterion that would enable one to say just why such phenomena could be caused more easily in some pieces of apparatus than in others, or why with some pieces of apparatus flashbacks could be produced at times quite readily and at other times with difficulty. Finally the general quality of the welds produced during test, although executed with the greatest care and shown by tensile tests to be of a higher strength than is generally secured in most welding shops, was far from satisfactory.

It was evident that further information was essential if a satisfactory analysis of welding-blowpipe performance was to be made. The greatest discrepancy from what was expected appeared to be in the high gas ratios obtained and the first attempt to answer the problem was made by a study of gas-ratio phenomena. This seemed particularly desirable as it has been very firmly held by almost all authorities that good welding cannot be done with blowpipes having a high gas ratio.

An extensive series of supplementary gas-ratio tests was accordingly carried out. As a result of these tests a phenomenon of exceeding interest was developed, and gas ratios aproaching very nearly the theoretical value obtained. The value of these tests will be considered later under the subject of gas ratio. The results obtained accounted partly for the quality of the welding work secured. In some respects though they added increased confusion by lack of consistency.

In further study of the data secured by the prescribed tests, it was noticed that blowpipes that seemed especially susceptible to flashback were those in which the oxygen was delivered to the blowpipe at a pressure very much in excess of that at which the acetylene was delivered. It was further noticed that even among such blowpipes inconsistencies appeared. Critical examination of tip design in these blowpipes suggested a possible explanation. On this basis another series of supplementary tests was made, from the results of which data were secured that clearly explain the cause of flashback phenomena.

85. The logical continuance of the theory evolved for flashback leads directly to the question of safety in operation and correct gas ratio and will explain, in large part, the reason for so large a proportion of oxy-acetylene welds being of inferior grade.

In the more careful welding operations very great pains are usually taken to burn out oxide or slag pockets, etc., with the result that the tip end is forced down into a confined space. Even with such care welds are found to be oxidized. The bottom of the V of a weld is almost always oxidized, while the upper portion may show more or less of the clean cast metal. It has been known for years that a shaky-handed welder could not make sound welds. It has also been known that certain blowpipes, as regards flashback, were particularly susceptible to the nearness with which the blowpipe tip approached the welding surface. Further, some at least have known that after placing an ignited and properly adjusted blowpipe flat on a surface and then gradually raising the head, keeping the tip upon the surface meanwhile, the blowpipe would flash back after the head had been elevated to a certain angle. These are some of the facts that indicated that there was being developed at such times the detrimental back pressures.

140. All the data available as a result of the investigation bear out the logical development of the above theory: the high gas ratios during welding, the difference in gas ratios when identical tests are performed by different operators, the lower gas ratios when a blowpipe burns freely in air, the fluctuations in volume flows as determined by flowmeter readings taken every few minutes with gas pressures maintained within a few hundredths of a pound per square inch throughout the entire test period. Most convincing of all is the entirely unsatisfactory character of the entire group of test welds made during the investigation, a group of welds that probably was made with greater care than has ever been bestowed upon any other such set.

All past experience, including the experience gained during these tests, points to but one convincing conclusion, namely, that a

blowpipe designed to be absolutely free from flashback caused by any form of obstruction, under all working conditions, will also be the eminently safe blowpipe and the blowpipe that will with ordinary care produce sound welds. Such a blowpipe will be one so designed that, under all conditions of operation even to complete blocking of the gas exit at the tip end, there will be maintained a one-to-one volume delivery of each gas, at identical pressures. In comparison with these fundamentals there is no oxy-acetylene blow pipe on the market today that fulfills the conditions.

DISCUSSION

J. I. BANASH*:

The situation of oxy-acetylene gas welding and cutting is not really quite so gloomy as might be inferred from this paper. Practical considerations must not be forgotten.

A fundamental point which is a most important factor in welding—has not given proper consideration—the personal element.

It is claimed that expert welders and cutters were secured from navy yards. It is obvious from strength of welds produced and limits of cuts that the operators were not expert, as I understood the word in the welding industry, and therefore such data can only be considered as average and not as approaching maximum efficiencies now attainable.

The average strength of welds according to this paper is 39,200 pounds. I have data with me showing a series of recent tests on practically the same material and conditions by a welder classed as expert.

In this connection I find a couple of letters from which I would like to read a few paragraphs. Here are the results of some recent tests made under similar conditions:

Norway Iron Filler	55,600 lbs. per sq. in.
Lowest	53,400 lbs. per sq. in.
Highest	57,000 lbs. per sq. in.

That is about 16,000 pounds higher than is found in the paper. With mild steel filler better results were obtained. Tests were from 57,500 to 60,500, an average of 59,340. The welding was done with first class operators; thickness of metal one-half inch. The commentator also says:

"I have endeavored to show that dependable high strength welds are made unfailing by a properly trained operator, using the present day welding torch, as is obtained on the market today."

Continuing along this line, as regards cutting—again the operator does not seem to have obtained results in hand-cutting for maximum thickness which are today ordinary routine in foundries, forge shops and armor plate mills, where single cuts of eighteen inches to twenty-four inches for sustained lengths, and not merely short cuts, are regular practice as compared with the limiting maximum as stated in this paper.

Criticisms of engineering design of apparatus in this paper are based on deductions drawn from such tests and are unjustified since the capacity of the apparatus itself was evidently not fully attained by the operators.

It may be of interest to note that one severe criticism of present design should not in my opinion have been made. Preheating flames on cutting blowpipes are concluded to be too large and therefore wasteful. I want to point out that hand-cutters were used, mounted as machine cutters. It is common knowledge, derived from field experience that hand-cutters are more efficient with larger pre-heating flames than are at all necessary or desirable for machine cutting.

This is no brief for the perfection of present apparatus, and any new information that may be gleaned from this paper will be widely and avidly absorbed by the industry.

I would like to read one or two features from a letter of a well known metallurgist. As I coincide with his information, it can become a part of my discussion.

Consulting Engineer, New York City.

Paragraph 57. The writer understands that the conclusions of the relative showing of the torches are subject to criticism, because the torches were used under conditions for which they were not adapted. A valid objection holds because of the importance of the personal equation in both cutting and welding. Manipulation means everything and, consequently, any equipment, except that which was specially designed for a given operating condition, would obviously be denied the greatest asset it could have, namely, skilled individual supervision.

Paragraph 62-A. The subject matter of this paragraph is a strong indictment of the present blowpipe equipment. However, much of the irregularities, about which the author complains, can be discounted by the considerations mentioned immediately preceding the above.

Paragraph 63. What is apparently meant to be an indictment of cutting torches can be taken in the opposite manner here. It is hard to see how a single torch could be designed to be equally efficient on all thicknesses of metal, granting the author's requirements for an efficient torch.

Paragraph 81. Objection is raised to the last sentence of this paragraph. The statement as it stands, without further explantation, furnishes a very serious indictment of this whole test work.

Paragraph 85. The sentiment of this paragraph is good only as far as it goes, which is only a short distance in the direction of stating the whole facts. The skill and experience of the welder, the quality of the welding wire, the mass and consumption of the material, and so forth, should in all fairness be mentioned in connection with a statement like that made in this paragraph.

Paragraph 140. The concluding sentence of this paragraph seems to typify the dominant note in which the conclusions from this test work have been drawn. By continually referring back to the extreme nicety of the test apparatus, much more important considerations have been lost sight of. The duplication or refinement of accessory equipment is bootless without most painstaking attention to the personal element, or to the every-day considerations of practical welding.

S. V. JAMES*: At the suggestion of Mr. Banash who has just spoken, I rise as a representative of the Underwriters' Laboratories, and can speak from experience in testing a great many types of blowpipes. The point which I feel ought to be brought out in this connection is that the safety of torches depends on a number of items in mechanical construction and in operating methods which are much more important than the question of flashback. The writer has devoted considerable space to a discussion of flashback, and has outlined some very interesting statements, but my impression from his emphasis of that point would be that he tends to overstress the hazard due to flashback. In other work of testing torches at the laboratories, we have found, as he states, practically any torch under certain conditions can be made to flashback, but we also take into consideration a very considerable field experience, where we have hundreds of these torches under all conditions of service, and we have yet to hear of authentic cases of serious trouble due to this cause.

MR. FAIRBANKS**: I would like to ask Mr. Johnston what precautions were taken to assure practical welders?

MR. JOHNSTON: The welders that we had were taken from the Naval Gun Factory of Washington, D. C., which I believe is acknowledged as having one of the best welding shops in the Navy Department. Those welders were brought to the Bureau of Standards. They were put to work for about two weeks to see what they could do. They welded under test conditions for tensile strength tests and bending tests and so forth. In order to make sure, because some of us at the Bureau of

Underwriters' Laboratories, Inc.

**Chairman, Boiler Code Committee, A. S. M. E.*

Standards probably had not had the experience that others had had, and therefore were not capable of sizing up a welder, we brought in as consultant engineer Mr. S. W. Miller of the Rochester Welding Works. Mr. Miller was down there and saw the operation of those welders. If he had any suggestion to make, it was freely given. It was Mr. Miller's opinion that the welders we had were far above the average welder. That was expressed personally, his statement being that "They were all right." Now as confirmatory of that, there were eleven out of fourteen manufacturers' representatives present, and I have up to the present time heard absolutely no comment reflecting on the competency of the welders.

MR. STUART PLUMLEY:*

The statement is made in No. 9, under "F" that the limit of cutting with the process, with apparatus of standard design, is approximately 12-in. Every one knows who has had much experience with oxy-acetyelene cutting, that standard hand cutting torches similar to those used in these tests, are capable, and have cut in many instances, up to at least 18 in., and in some cases more. The writer has personally seen a standard hand cutting torch make a sustained cut in steel, in one direction, of 36 in. With standard machine cutting torches, the oxy-acetylene process will cut up to 24 and 30-in. and such work is being accomplished daily in some of our larger plants.

The conclusions reached regarding the strength of welds are, I presume, based largely upon the results determined in the test. I wish to state that these results are far lower than those which have been obtained by many others.

MR. JOHNSTON: One of the criticisms was we were using hand torches with mechanically operated machines. Therefore I believe the feeling was that the torches were improperly used. Gentlemen, that was done with just one idea in mind,—to get rid of the personal equation. We wanted to get the value of the torch and not the operator. Consequently every manufacturer that submitted his apparatus to that test knew ahead of time what the material was, and that the test was going to be made by mechanically operated devices, and he was asked to furnish the pressure to use and the tip size.

There is one other thing I would like to bring up here, the statement which has been brought out as being an indictment of the whole thing, and that is, an unsatisfactory side of welds are looked at from this standpoint. Mr. Miller points out that the weld is cast material and therefore should have the characteristics of cast material. A very large percentage of the welds that are made are not cast materials. You will get spots here and there of casts, but you do not get casts from the top of the material down to the bottom. In fact, I think practically every man who has followed welds will find at the bottom of the "V" there is cast material. My experience, while primarily with the Bureau of Standards, has been obtained by looking around a good deal at different tests, and I believe invariably at the bottom of the material you will find casts. I think the reason is this: That down in the bottom you get an interference with the gas flow. You cannot help it. If the members are interested in that, they might refer to the tests reported in *The Welding Engineer* a short time ago, where the writer in Philadelphia spread a couple of plates in a single "V", one and one-eighth inch, and spread then three inches, and they got entirely different characteristics and could not account for it. Where he separated three inches he had a large space for the gas to circulate around and was cutting down back pressure.

Now in regard to safety. This investigation has not set out to knock manufacturers. We were after data. The spirit of the thing is not to knock anything. It is simply to show there is room for improvement in welding apparatus and cutting apparatus. The fact that we get irregular data shows that there must be more or less of the unknown in the designs. I do not for a minute want to make the thing appear as gloomy. The point I want to bring out is that when you get a torch or blowpipe, whatever you want to call it, that is free from flashback, you are simultaneously going to get the one that is going to do the best kind of welding. You will notice if you look back at the table of so-called flashback tests that there are quite a number of them that showed flashbacks. Some of them actually went back into the gas line. That torch might have dangerous possibilities. I do not say it is absolutely dangerous. It is just an indication that there is a condition there that may be under certain circumstances dangerous, and where torches showed anything like that they were tested again and again to make sure that the condition actually existed. Now, incidentally, the report on flashback there is not the report that would be brought out today, if we had made those tests after we really understood what the flashback was and how it was made and how to make flashback tests. As a matter of fact, practically any torch today can be flashed easily. It is not necessarily dangerous.

*District Manager, Davis Bournonville Co.

WRECKING A STEEL BRIDGE

The Rush street bridge, Chicago, which has been discontinued since the opening of the new boulevard link bridge, has been sold to a wrecking company for junk. The Ketler-Elliott Co., who purchased the old bridge for $500, are using oxy-acetylene cutting torches for all metal cutting work on the structure.

The illustration (furnished by courtesy of Torchweld Equipment Co.) shows one large section of the bridge with a cutting crew getting ready to cut through one of the members.

The Passing of the Rush Street Bridge

Dismembered steel beams are dropped upon barges anchored alongside the bridge and floated away. It is estimated that approximately 250 tons of metal will be salvaged for junk.

The first bridge across the Chicago river at this point was erected in 1854, wooden structure which was destroyed by the Chicago fire in 1871. In 1884 the bridge now being wrecked was built at a cost of $50,000. It was 240 feet long and sixty feet wide and until 1900 was operated by steam. The connecting link bridge which replaces the Rush street structure was recently completed at a cost of $16,000,000.

NEW SOUTH SAN FRANCISCO DETINNING PLANT OF THE METAL AND THERMIT CORPORATION

In order to handle more satisfactorily its growing detinning business in the West, the Metal & Thermit Corporation has constructed and will shortly place in operation in South San Francisco, Cal., a large new plant for the production of detinned billets, in addition to the detinning plants already operated by this company for several years at Chrome, N. J., and East Chicago, Ind.

The new South San Francisco plant has also been equipped with a large welding shop containing excellent equipment and facilities for undertaking repairing by the thermit process.

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WHAT does it cost you every time your welding or cutting work is held up? Chances are it often runs into hundreds of dollars.

And this is all **needless** waste. The Carbic System insures your gas supply at all times and for less than the cost of two gas tanks.

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Carbic torches may be used with either high or low pressure equipment.

No matter what system of oxy-acetylene welding and cutting you are now using, you should have a Carbic outfit - just as a matter of **insurance.** Later on you will use it continually.

Carbic is mighty cheap insurance. Ask us to prove it.

The Carbic line is complete, including generators, torches, regulators, and all other necessary apparatus and supplies.

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Carbic Cakes save money, time and patience, and yield a purer gas

TEXAS MAN PATENTS NEW TYPE STRUCTURE

Among the advantages claimed for a new type of structure that has been developed recently in the Southwest, are great strength and durability, economy of fabrication, and exceptional sanitary features. The design and method of fabricating are protected by a patent issued to W. D. Clay, president of the Clay Boiler and Machine Company, of Ranger, Texas.

The "Clay Designed Truss Welded Frame Structure" differs from the heavy steel structures generally erected in that the framework is constructed of tubing in which the joints are made by welding. The completed frame is in reality one piece, eliminating entirely the necessity for rivets, bolts, screws or screwed joints. The roof, sidewalls and floors may be of any building material desired. The design is such that buildings of any required dimension can be erected without interior pillars. The claim of superior strength is based on the use of tubing, which, under certain kinds of stresses, is stronger than any other structural form of equal weight; and to the fact that the oxy-acetylene welded joint, which is remarkably tough, can be made even stronger than the sections of tubing joined, thus reinforcing the structural members instead of reducing their strength, as is unavoidable where threads are cut for screwed connections or holes drilled for bolts or rivets. The smooth finish of the welded joints also renders them less susceptible to rust and deterioration, thereby adding to the factor of durability. Economy of fabrication, both for material and labor, is claimed on the basis of the saving in tonnage on any required factor of strength and on the fact that the welded joint can be made more cheaply than either the screwed joint or the riveted or bolted joint. The matter of sanitation is simply one of trim construction that eliminates the ordinary recesses and surfaces for gathering and holding dirt.

Clay Designed Truss Welded Frame Structure.

The adaptation of tubing to structural work was first conceived by Mr. Clay to meet the difficulty of obtaining building material in the oil fields during the recent adverse conditions that prevailed in the Southwest, and the first building erected was a comparatively small structure fabricated from odds and ends of pipe, of which there is always an abundant supply in the oil districts. The success of this experimental step led to the erection of a larger building, the shop structure shown in the accompanying illustrations. In this building, 50 ft. by 100 ft., all of the joints in the tubing were welded. The side, ends and roof are of corrugated iron and the floor of concrete. The trusses were separately tested by attaching a block and tackle to the bottom chords, one at a time, and hoisting a heavy motor truck clear of the ground.

The Clay Boiler and Machine Company is now erecting a still larger building for its own plant, in Dallas. This structure will be 100 ft. by 200 ft. The sides and ends will be of concrete, 10 inches in thickness, finished in marble; the roof will be sheathed with reinforced concrete slabs two inches thick; there will be a skylight 28 feet wide and two 2½-foot ventilator shafts, skylight and shafts extending the entire length of the building; the floor will be of concrete; and there will be steel sash windows and roller doors. A large chain hoist will be swung to one of the trusses for the loading and unloading of heavy weights.

This will be the largest building of its type yet erected, but it is stated that it by no means indicates the limit of dimensions to which the new welded tubular construction may be advantageously adapted. Mr. Clay states that any number of stories and any size of floor space can be built in this way, and that his company will draw up plans and execute the construction of buildings of the kind anywhere in the country. The new departure will be observed with considerable interest in building and engineering circles.

WELDING HYDRAULIC PRESS BASE

A typical instance of the practical application of oxy-acetylene welding in repair and maintenance of plant equipment is illustrated in the accompanying cut, which shows operators welding the base of a 250-ton hydraulic press that was badly broken in service.

The heavy base was broken entirely through, the fracture extending diagonally across the center. To properly bring the parts together for welding it was necessary to bind them with a chain and supplement this with a steel plate securely bolted to the uprights.

Device Employed for Bringing Parts Together.

The necessary chamfering was done to secure penetration and proper bonding throughout the joint, and an improvised preheating furnace was then built up of "I" beams and loose brick. Approximately 126 pounds of charcoal and 200 pounds of asbestos paper for covering were used.

When the base was brought to proper heat, openings were made in the asbestos sheeting to afford access to the work in operating the torches and filling rods, and the actual welding began. After the work had progressed to a point where the girding interfered with the operators, the chain was removed, the steel plate being then sufficient to keep the parts properly aligned. There were 44 inches of linear welds (4½ inches deep) besides an area of 8 in. x 4½ in. that was missing and had to be built up. After welding the entire base was allowed to cool slowly in the furnace.

WELDING EXTENSIONS ON DRILLS

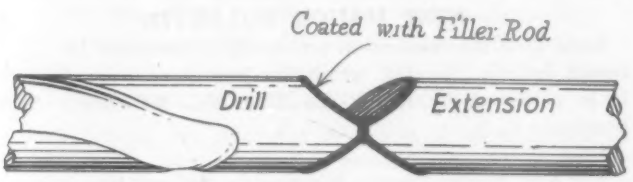
Minneapolis,
Tuesday.

Dear Ed:—

The lad who wrote "The Bells of Hell Go Ting-a-ling-a-ling for You But Not for Me," was away off in my estimation. It's been doing nothing but rain for these past five days and while it's not my conception of good form to fill letters with talks on the weather, yet it sort of gets a fellow's goat to land in all this "ducky" atmosphere. I got in here last night and thought sure someone would turn off the water before daybreak but no chance. Today it's worse than ever. When I was passing over the grand old Mississippi this A. M. I saw all those "pappies" who own the flour mills lined up on the banks clapping their hands because the river was rising and that of course meant more power for them. "It's an ill wind what don't blow somebody good," isn't it?

But to get down to welding. I didnt get over to Omaha this week because the company changed my routing; consequently I didn't get in touch with that shop that pulls all those good stunts I was telling you about. Ought to get around there in about ten days though, so cheer up.

Don't know whether it was me, the weather or just simply fate this week; at any rate, with one exception, every shop I was in was pulling just the ordinary run of welding jobs in the ordinary way so they wouldn't interest you in the least. However, this one exception was a place in Cedar Rapids and I figured this stunt ought to be about as welcome to you as pay day back there in Michigan.



How the Ends Are Prepared for Welding

Al's shop rather appealed to me right off for some reason or other so after we jazzed a bit I asked permission to watch some of the welding. Al has an awful nice way about him, sort of a "no trouble at all" feeling and you know he truly means it. The next to the last table got my eye because I hadn't seen so many twist drills all together outside of a stock room since I knocked around some of those places in Cleveland and Detroit.

"Why all the drills?" I asked.

"Oh, those! We're welding an extension," he answered.

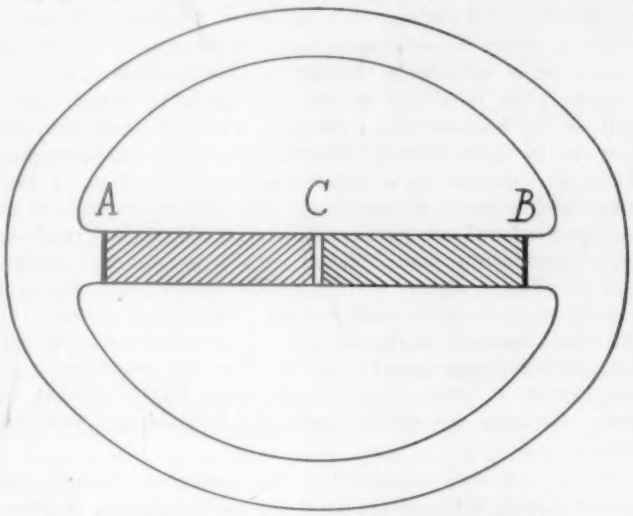
Well, Ed, I had seen many an extension welded on a twist drill but not in quite the same manner so determined I'd draw him out a little.

"That's sure a new one on me, Al. Would you mind telling me why you bevel them off like that and treat them as you do? Everybody I've noticed simply lined the piece for the extension up with the shank of the drill and made a butt weld."

"Ordinarily the method you mention is perfectly satisfactory but as a rule the drills are small and probably aren't subject to much strain," he said. "Now in our case we had to do quite a bit of experimenting before we hit on the method we use at present. You see these drills are all pretty good size so the strain is normally very great, but to make matters worse the metal they work on is about the toughest proposition going, so you see what we are up against. At first we tried welding the extensions on by simply butting the ends together, after grinding them off a little to make a small 'V,' and then fused them with a filler rod of nickel steel. These welds came out so hard and brittle that they all broke off after being used only a short while. In trying to figure out the cause we concluded that the high percentage of carbon in the drills and extension rods was probably the reason for our failures. While making these welds we made it a point to keep our flame just as soft as possible because we have found that that is one of the big secrets in making successful steel welds but strive as we might we couldn't keep our metal from burning."

"I know the way," I butted in, "I'll bet the sparks shot out just like the water out of one of those lawn sprinklers."

"You said a mouthful there," he continued, "and in addition to the big shower of sparks we could see a milky white foam floating around in our weld, and after making dead sure it wasn't any fault of the torch we proceeded to try our hand at brazing. Well, we had a little better success with our brazing but the load was too heavy and they continued to break so after scratching our heads awhile we hit upon a stunt we had used with very good results on jobs of a little different type. This method is the one you see us using now and it has proved very successful.



Replacement of Old by New Metal Is the Best Solution

"You see first of all we bevel off the ends to be welded on both sides, the drill as well as the extension." Here he picked up one of the drills. "You will note that the bevel is just about forty-five degrees on each side, making the end after it is prepared look like a dull cold chisel. We found it best not to grind down to a knife edge because it burnt up, so we leave about an eighth of an inch here on the end flat. The end of the extension as you see is prepared the same way. Our next move is to coat these ends with our nickel-steel filler rod. We weld on just enough of our filler to give our ends a good coating."

"Just a minute," I interrupted, "Don't you have the same trouble with your oxidation when you weld on this layer of filler rod as you did with that first method you mentioned?"

"Practically none. You see we are not working down in a 'V' but right out in the open where we can just barely melt our surface to get our rod to flow. If there should be any oxide appear we fix that because we dress all the ends up on the emery wheel again to take off any scale or oxide that might appear. Here's one over on the stand here that's been ground. It's a pretty nice surface, isn't it? After that there's nothing to it. We just lay our pieces in the jig over there so as to keep them in line; butt the prepared ends together and make our weld. However, in this case we are not trying to weld three different kinds of steel together like

we did in our first attempts. There we had a high carbon steel in the drill itself, which probably contained some other alloy. Our extension was a different grade and so was the filler rod we used. In our present method we have only the one kind of steel to fuse; it sure is turning the trick and our customer is more than pleased."

"If the customer passes judgment in your favor, what more can you ask?" I inquired. "That's the bird we're all trying to please but tell me, Al, you intimated that you used this same trick on some of your other jobs." Then I told him all about you and our arrangement to pick up stunts so you could use them in your shop. I wanted to get all the dope I could for you but I could see plain enough that he thought that he had given me enough for one time but finally after explaining that you were away off in another state and were an ex-service man he loosened up a little.

"You see it's this way with most of us welders," he said, "we don't have anybody come around and give us pointers; we have to use our head and learn by experience. It's on the out-of-the-ordinary job we get paid, not so much for the actual work we do, but for the 'know-how' so in a way you can't blame us for holding on to what we got. If we went around telling everything we know it would simply help our competitors and kill our own business. There's nothing personal in this you understand but I think you'll find this the concensus of opinion on the part of most welders. Now concerning your friend; if he has any initiative about him he will see for himself where the stunt I've just gone over with you can be used in many different ways and with variations. Take for example on a boiler job where the plate is eaten away and a patch is necessary. Sometimes it's out of the question to cut back far enough to find the original thickness on account of the scale. When a patch is tacked in position and an effort made to weld it to the scaled plate, the scale usually works into the weld making it brittle and porous. On the other hand if the scaled part is first worked over with the torch and new metal from the filler rod fused on, it not only forms a better base for the weld but it anneals the plate and helps the welder materially in making a first-class repair.

"Here's another application," he continued, "which may appear a little different but its along the same line. A couple of months ago we had a number of brass castings something like this." He sketched off the drawing which I'm enclosing. "These castings were in a pretty bad way. Full of sand and blowholes and all of them had breaks located somewhere between the points (A) and (B). To make a long story short, our welds would not hold regardless of how much or where we preheated. The break would always open up directly in, or just adjoining our weld. In desperation more than anything else we cut out and removed that section from (A) and (B) and welded in two pieces of bar stock making our welds at (A) and (B) but leaving the ends at (C) open. When both these welds were cool we threw a heat in the rim and welded the ends of the two new pieces at (C). This method proved very satisfactory although taking more time and costing more than you would suppose such a job would warrant, looking at it from the surface. And so it goes, while I have only mentioned steel and brass in passing, the same is true of cast iron grates or stove castings that are all burnt out and many other metals where the grade is low or naturally weak. Do you see the point?"

"You bet I do," I replied, and was going to tell him how much I appreciated getting this dope but just then he was called to the phone and a minute later I saw him hop into his machine in great haste so knew he was off on an urgent call. I strolled back to take another slant at the lad turning out those drills and say, Ed, they certainly were coming out nice; you know, the metal just as clear and smooth, not a sign of scale or anything else.

Well, Ed, the epistle grows longer than I expected but before I close I'd like to say just one thing. If you ever want to see a good healthy cloudburst (my idea of what the natives call rain) just run up to Minneapolis some time.

Yours without a struggle,

SHEP.

METAL AND THERMIT CORPORATION CHANGES TERRITORIAL ASSIGNMENTS

William Aldrich, who has recently been in charge of thermit welding in the Southern territory of the Metal & Thermit Corporation, New York, has been transferred to the Western territory of this company. From 1899 to 1908 Mr. Aldrich was associated intermittently with the Milwaukee Electric Railway & Light Company, Milwaukee, Wis. In 1909 he joined the former Goldschmidt Thermit Company. Since then he has traveled in every state in the United States, also in Canada, West Indies, Central America, Panama and the tropics in the interests of thermit, and in so doing has obtained vast experience in all branches of this work. Mr. Aldrich will travel extensively in the far Western states of California, Oregon, Washington, Idaho, Nevada, Utah and Arizona, and will make his headquarters at the new South San Francisco office of the Metal & Thermit Corporation.

William H. Moore who until recently was assigned to the Chicago territory, now has charge of the Southern territory. Mr. Moore has also had a most thorough practical experience in all forms of thermit welding.

NEW HAUCK BULLETIN

Some good information on preheating is contained in the new Hauck bulletin, No. 127, which has just come from the press. It is published by the Hauck Mfg. Co., 122 Tenth Street, Brooklyn, N. Y.

The East Boston Electric Welding Co. has just been organized at 85 Border Street, East Boston, Mass., to operate as a machine shop and welding works. The head of the company is Mr. Edward Lundberg.

The District Chemical, Ltd., 1 Fernchurch Avenue, London, England, have just taken out a patent for a new purifying material for acetylene gas, called "Suder."

The name and address of the Atlantic Welding Works has been changed to Atlantic Welded Products Company, 1725-27 North Howard Street, Philadelphia. There is no change in management, but it is announced that floor space and facilities have been increased. In the future all business will be done under the name of Atlantic Welded Products Company.

NEW OIL TORCH USES COMPRESSED AIR

The Norton Safety Vacuum Torch recently announced by the Norton Mfg. Co., 18 Trement Street, Boston, Mass., operates by a vacuum created by the passage of compressed air through the burner head. It is of heavy steel construction and portable, and burns either fuel oil or kerosene.

NEW OXYGEN PLANT AUGURS INDUSTRIAL IMPROVEMENT

In these days of general industrial improvement it is refreshing to note the spirit of optimism evidenced in the announcement recently authorized, that the Dominion Oxygen Company, Limited, will break ground in mid-July for a new quarter-of-a-million-dollar oxygen plant at Montreal, which will double the company's present capacity. The building will be 100x100 ft., and will be substantially a duplicate of the company's Toronto plant, which until now has supplied oxygen to Canadian industrial users through five district distributing stations.

PROCEEDINGS *of the* AMERICAN WELDING SOCIETY

33 West 39th Street, New York

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GROWTH OF WELDING INDUSTRY

The Electric-Arc Welding Committee, of which Mr. H. M. Hobart is chairman, has recently circularized the manufacturers of welding apparatus and welding wire and has thereby obtained very interesting data on the growth of the industry. In a number of the replies received from the wire manufacturers no distinction was made between gas and electric welding wire sales.

These figures demonstrate conclusively that the use of welding for the year 1920 in our various industries was double that for the year 1919. The nation is waking up to the enormous economic benefits and possibilities of welding.

TECHNICAL BULLETIN NO. 1

Technical Bulletin No. 1 of the American Welding Society is now available for distribution. This bulletin contains Specifications for Standard Tests for Welds as recommended by the American Bureau of Welding. These specifications will be considered as standard for the period of one year.

Material of considerable importance and value was first printed in *The Welding Engineer*—the official organ—and then reprinted in the more permanent bulletin form. Bulletins of this nature will be of the standard size adopted by the other technical societies—6 in. x 9 in. In accordance with the policy adopted by other scientific and technical societies, a charge will be made for such bulletins. In the case of members this charge will cover the cost of printing and in the case of non-members, a slightly greater amount will be charged to cover the necessary overhead expenses.

The price of technical bulletin No. 1 is 25c to members and 50c to non-members. Orders for the same may be addressed to the Secretary of the Society. Remittances of less than $1.00 may be made with stamps.

SPECIFICATIONS FOR STEEL TO BE WELDED

Recognizing that the quality and composition of the base metal has an important bearing on the quality of the resulting weld, the bureau created a committee to deal with the specifications for steel to be welded. This committee, of which Mr. W. J. Beck is chairman, is co-operating with the American Society for Testing Materials and will make use of any existing specifications wherever such specifications will be found suitable for welding purposes and modifying them only when necessary.

WELDING WIRE SPECIFICATIONS

Specifications for welding wire, gas and electric, have been prepared by the Welding Wire Specifications Committee for the welding of mild steel. They will be published shortly and thus made available for distribution. Specifications have also been prepared to meet the demand for a high carbon electric welding wire for the building up of worn surfaces where great resistance to abrasive wear is desired.

A special bulletin will be issued on coated materials, including the analysis of coated electrodes found to be successful for various welding purposes. A second bulletin will include wire for gas welding of high carbon, nickel steel, brass, bronze and aluminum. These bulletins will be issued to serve as a preliminary guide until definite recommendations may be offered.

STANDARDIZATION OF RESISTANCE WELDING

The Resistance Welding Committee, of which Mr. H. Lemp is chairman, has appointed sub-committees to formulate plans on standardization of nomenclature, rating of welding transformers and units of energy for welding, and preparing critical summaries of the art as it exists today. Before proceeding with any new work it was felt that it was better to take account of stock as it now exists and build a solid foundation on the basis of which future needed research may be properly planned. In order to carry out this work the field of resistance welding was divided under five sub-divisions:

(1) Butt Welding.
(2) Seam Welding.
(3) Spot Welding.
(4) Percussive Welding.
(5) Direct resistance method of heating for the purposes of (a) annealing, (b) hardening, (c) brazing, (d) heating of rivets.

Considerable progress has been made on the standardization of the welding transformers which will prove valuable to the manufacturer, user and central station man.

A critical summary on butt welding will soon be finished and ready for publication.

WORK OF GAS WELDING COMMITTEE STARTED

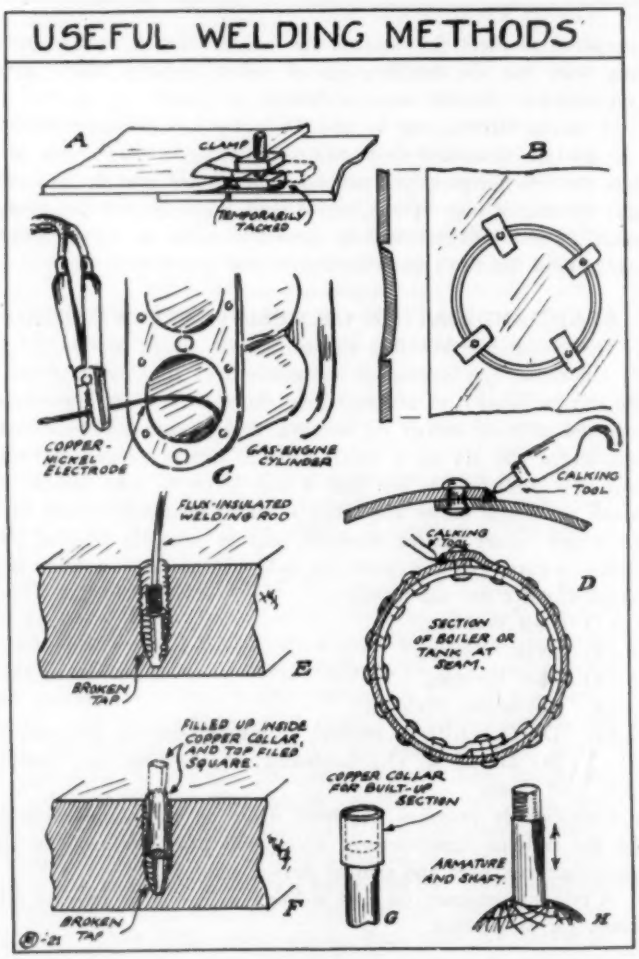
At the annual meeting of the American Welding Society, Mr. S. W. Miller reported that his committee will concentrate their first efforts in preparing a summary on pipe welding which would embody detailed information of the best existing knowledge on the gas welding of pipes. Mr. Miller feels that the interests of welding can be advanced by furnishing the public with fundamental and detailed information as to how such jobs ought to be done.

Owing to the large amount of space required for the publication of Mr. Johnston's paper, with discussions, the publication of the usual paper under the Society Proceedings is omitted in this issue.

USEFUL ARC WELDING APPLICATIONS

SOME very useful welding dodges are shown in the illustration: for instance, illustration A shows method of making a lapped plate joint where the edges do not come together flat or the plate bulges between the means provided to hold them together, such as a few bolt holes spaced some distance apart.

Another use for this scheme is getting refractory plates and angles in place in ship barge work and perhaps later this scheme will be used in large size ships. The idea is simply to tack a bolt by its head upside down on the lower or inner plate, tacking it by single fillet across two edges only. The heavier plate used as a clamp is then brought down with a nut to bring the upper or outer warped plate into place. After this plate is tacked down and nut can be removed and the bolt knocked off at right angles to the weld or if this proves troublesome, one of the welded beads can be chipped off and then the bolt head can be knocked



loose pushing from that direction. This method should be acknowledged to Mr. W. T. Bonner, who devised it and first used it in ship work.

Illustration "B" shows a method of putting in a patch in a plate whether a plane, round or warped surface where much trouble has been experienced in keeping a welded patch from cracking during the welding or after welding or in service or where from exerience such danger is liable. In the cross being that the contraction during welding will just about take section you will note the patch is slightly dished, the idea up the dishing and straighten out the plate that is used as a patch relieving all strains. The ideal patch in this case is a circular one but oft-times a true circle cannot be arranged for but the nearer a circle is approached the better the chances are for success. For instance, if the hole is rectangular, rounding the edges will help a whole lot and if the hole is add shaped, making it an ellipse or egg shape will approximate the circle where the stresses are even all around.

Where a machine formed dished patch cannot be obtained an ordinary sheet can be dished by hammering. If the sheet is over ¼" thick is should be hammered hot and it is best hammered hot for any thickness.

The four clamps show an easy method of holding the plate in place, simply putting a bolt through from the inside and clamping down with a heavy plate and nut on the outside. These clamps should be left in place as long as possible in this rigid system of welding. This system not being at all applicable to the non-rigid system, as it is a rigid weld with the stress transferred to the dished patch.

Illustration "D" shows an apparently easy job to the uninitiated, that is the welding of a caulking edge on a boiler or tank, This job is far from being easy, however, because in most cases the welder is called to fix up a leaky seam and the cause of a leaky seam is movement of the plates or rivets. Simply running a caulking edge along the joint will in general make the seam tight when not in use, but upon the boiler tank being put in service, especially under pressure, the plates are liable to assume a different shape or position under load than when quiet, the strain then being entirely brought upon the weld whereat it is broken or pulled away, adequate provision not having been provided to equal the strength of the plates to which it is welded.

It is not always the correct thing to do to make this weld stronger than the plate. In a boiler, for instance, where rivets have been installed for part of the seam, it is best to fire up the boiler and put it under full pressure, thus straining it into its final position before welding.

Illustration "D" shows how a caulking seam should be approaching with the tool so as not to drive the weld under the plate. A great deal of experience is needed in caulking for arc welding just as caulking experience is needed for rivet work. Every boiler maker knows that an amateur will do with a caulking tool more harm than good and similarly in welding; too much caulking is harmful instead of beneficial. A multiplicity of light rapid blows is the only reliable caulking method on a weld, whether the caulking is for a smooth finish or to make the surface denser against weeping. Also, too much caulking will cause the surface of the weld to crumble and repeated caulking of this nature will finally result in crumbling the welding all away.

Caulking rough looking welds for a finish is common practice, but in this case the rougher part of the weld must be chipped or ground approximately the size before caulking, or the efficiency of the weld will be much lowered, both as to strength and tightness. Working a weld cold except on the surface would be similar to working a sheet cold of similar dimensions which could be easily cracked or ruined. Working the weld hot is a different matter, but it is almost impossible to caulk metal arc welding while hot, although in many instances on very careful work each inch or two is caulked while hot (just after it is put down) with a ball peen hammer in the hands of the welder.

In very few instances the weld can be reheated and caulked but these are very scarce as reheating would in general cause more strain and stresses than would be relieved by caulking.

Illustration "C" shows the proper method of filling-in scored cylinders with the latest development, the copper nickel electrode, which has the property of so merging with cast iron that the usual hard spot underneath the weld is done away with. This copper nickel electrode is far better than the old pure nickel peened in, as the copper nickel can be welded in

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**Instruction from the handbook of the Electric Arc Cutting & Welding Co., 152 Jelliff Ave., Newark, N. J. Copies of the complete instruction book may be had from this company at $1.25 each.*

continuously; care being taken not to get the cylinder wall too hot, that is weld not over two or three inches at a time. The excess metal can be machined off with any common ordinary tool or a lathe or boring mill or can be ground nearly to size and can then be rolled and lapped afterwards.

The illustration shows the electrode bent so that the tip is approximately at right angles to the score to be filled. This is a repetition of previous instructions on this point, i. e. that no arc weld can be made properly unless the electrode tip is very nearly at right angles to the work piece surface. For this copper-nickel electrode even although the score is very small at least ⅛" size electrode must be used, as 130 amperes is about the smallest good value that will reliably weld the cast iron and a ⅛" electrode is the smallest that will carry this current. For larger work a ¼" electrode is best.

Illustrations "E" and "F" show two methods of reclaiming broken taps in thick pieces or castings which method is not new by any means. There is nothing more exasperating than to break a tap, especially a bottoming tap below the surface of the main piece. The tap must be gotten out or the work is ruined. If the hole is large an insulated rod can be used to build up on the tap until it is above the surface where a square can be filed on it and the tap backed out. The insulation on the rod helps to prevent spoiling of the thread by accidentally contact. The method here is to weld a bit at a time or if you have become expert at dipping in and out of the puddle, the building-up can be made practically continuously by shorting the arc in the puddle and pulling away to a very short arc before the puddle freezes. This method is also very useful in building-up oft-times at other places than in a hole.

Where the hole is small an extra tube shoved down inside the threads will allow of the added metal being built-up to the surface in order to file a wrench grip to back out the tap. Illustration "G" shows a method of building up a broken or chewed off end of a shaft where the end is not more than 4" to 6" long. The copper collar is here banded on or friction held and the weld made by successive beads on the inside, the collar being not more than 1½" or 2" higher than the welding surface at any time, being pushed up successively as the building-up progresses. This method is far better for short pieces than trying to weld on a piece as it does away with the necessity of veeing out, aligning, etc.

After the weld is made the copper collar should be removed and a finish made for subsequent machining by welding lengthwse of the shaft, similarly as is shown on the armature shaft, illustration "H." These welds should always be made lengthwise of the shaft in order to ensure an even deposit because in welding around the other way the welding setting is only rght for one position and is too hot for the vertical welding and not hot enough for the horizontal.

This welding of armature and other shafts, by the way, where the bearing is worn or scored or the key-way is chewed out, is one of the most useful applications of arc welding, as there is practically no danger of putting heat enough into the shaft to melt adjacent babbitt or ruin adjacent windings.

The illustration on the sheet and angle work show some special applications of joining two or three or even more of the regular structural members for structural work.

When joining two plates at an angle, if the sheets are left a bit spread the pieces can be joined reliably in the one weld. The wider the plates are apart, the more reliable will be the joining of the inner three pieces and at no time should the plates be apart a smaller distance than their thickness. The illustration to the right of this shows a method of stiffening a sheet either for attaching to an upright or not.

The angle bending and welding method shown in the center top is one of the most widely used applications of arc welding, but is shown as an idea to extend the arc as arc welding is only started. You will note that any angle can be allowed for by cutting out the "V" to correspond. The illustration to the left of this shows a method of joining by a combination of arc welding and bolts, members which must be removable.

The window frame method itself is self-explanatory, it being found much easier to chamfer off the edge of the window slightly than to cut out the corner of the angle and try to make a flush weld and perhaps ending by having to chip the weld afterward. The corner sheet method is very similar to the joining of the three pieces explained at the start of this section. A weld made in this manner and finished off a bit is the prettiest joint yet devised.

Where an angle would be objectionable or the plates are small the weld can be made from the inside forming an angle of the weld with the two plates. The plates can then be butted on the outside at a right angle and not welded at all or just welded for finish only.

A unique method of welding is shown to the left of this where a lapped joint must be made for a third member and the three of them joined. The illustration shows how one of the plates is nicked out and the other one laid over the notch half way the width of the notch so that the weld can be made through this opening to the third member, at the same time joining the two sheets.

The illustration of the veed out plates is shown for several reasons, one that the angle of the "V" must vary with the thickness of the plate for an even flush butt weld, being thicker for heavy plates. In general, however, a right angle opening is the maximum required.

Welding long seams butted brings up the question of the rigid or non-rigid method. In the rigid method the plates are clamped or bolted in their final alignment and the weld made in any manner, either continuously or broken up to spread the resulting contacting stresses over more time and plate. In the non-rigid system the plate is placed close together at one end and the part at the other end and the weld made continuously closing in the opening at an even rate which will just bring the closed ends together at the finish of the weld. This method requires more skill and experience than the non-rigid and in any ordinary job is not worth the trouble it entails, although for very careful work it may be desirable to use it where joining two pieces only.

It is evidently more out of place in setting in a patch as the only part of the patch on which this method can be used would be the first seam. There is a use for it, however, even in setting in patches in some very rare cases where the difference between success and failure depends on getting the first edge of the seam perfect so that it will not be pulled away due to the contracting strains when welding the opposite seams, or the seams at right angles which exert a more tearing pull than the opposite seams in contracting.

An aid which is hard to obtain but which has been found very useful in very careful work is to vibrate the work while making the weld by light blows of the hammer or vibrating the work directly after the weld is made, i. e. while it is cooling and contracting. The vibrations of an air hammer set for a light blow is the best means for accomplishing this.

SCOTT H. TOLMAN

Scott H. Tolman, president of the Tolman Mfg. Co., Boston, Mass., died at his home June 15th. Mr. Tolman was one of the well known manufacturers of oxy-acetylene welding apparatus, and had a host of good friends in the industry, who will sincerely mourn the loss of their pleasant associations with him.

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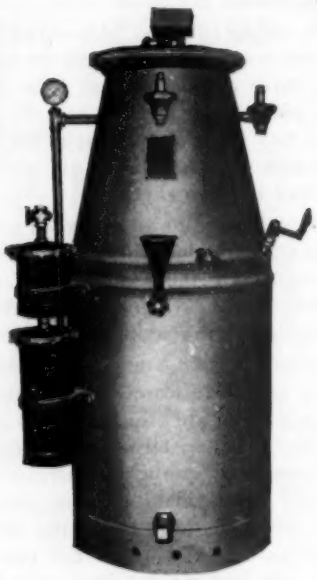

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For Sale—50-lb. capacity D-B acetylene generator. First class condition. Latest model. Used only a few months. Address Thos. K. Smith 1230 D St., S. E., Washington, D. C.

For Sale—Complete file of The Welding Engineer from the first issue up to and including December, 1920. Address 90, care The Welding Engineer.

Wanted to Purchase Machinery—Wanted a second-hand buttwelding machine for welding pipe up to 5 in.; also a small buttwelder for welding pipe up to 4 in. Address Adams Pipe & Supply Co., 1101 Haas Bldg., Los Angeles, Calif.

For Sale—REPAIR BOAT, equipped with complete Electric Welding Outfit, Air Compressor Tank Forge, etc.; 100 H. P. Boiler. All in fine working order. An ideal plant for repair work on vessels.
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Position Wanted—Electric arc welder; seven years experience, shipyard, drydock and repair work; competent to take charge of work of this nature; married; prefer location near Chicago or west of Chicago, but willing to go anywhere on attractive proposition; references. Address J. W. Howard, 3646 Cornelia Ave., Chicago, Ill.

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CURRENT WELDING LITERATURE

APPLICATION OF ARC WELDING IN MACHINERY CONSTRUCTON, by A. M. Candy.—Paper before the Society of Refrigerating Engineers.—Electrical Review, July 2.

CANADIAN CARBIDE.—A brief history of its growth and development at Shawinigan Falls.—Acetylene and Welding Journal, May.

CONCERNING ACETYLENE GENERATORS, by Marcel Piette.—It is well to recall from time to time certain fundamental principles applicable to the production of acetylene gas in generators of different types, which may be useful to users of autogenous welding in the choice of apparatus. Generally speaking, the productive power of acetylene generators is limited by the quantity of materials (water and carbide) mixed, the speed of decomposition, the possibility of conserving all the gas which is produced when turned off quickly, and the temperature not exceeding that of the center of decomposition. The principal quality which an acetylene generator must possess for use in welding is flexibility. And contrary to what many people suppose, the flexible generator is not only one which can furnish large quantities of gas on demand but one which is capable of storing up the surplus when the work is stopped, and delivering it later without loss. The first consideration to which the buyer should give attention is that of the capacity for real production in the machine which is offered to him.—Revue de la Soudure Autogene, May.

REPAIRING CAST IRON FLYWHEELS, PULLEY WHEELS AND GEARS.—In a series of eleven sketches the author illustrates the usual varieties of welding problems that are presented by broken wheels. The text is chiefly confined to a discussion of methods of avoiding cracks due to contraction.—Revue de la Soudure Autogene, May.

WELDING WITHOUT PREHEATING, by David Baxter.—Almost any part of an iron casting which is not surrounded by metal but is free to move with expansion and contraction may be welded without preheating, unless it is so heavy that preheating will be an assistance in melting the metal, thus saving gas.—American Blacksmith Auto and Tractor Shop, May.

THE KJELLBERG PROCESS OF ELECTRIC ARC WELDING.—The Kjellberg process employs the steel wire electrode covered with a coating of non-conducting material, to protect the fused metal from oxidation. The tensile strength of the weld can be varied within certain limits to suit the purpose required. It is possible also to obtain various degrees of hardness by altering the composition of the covering. The heat is localized within a very small area, consequently the danger of setting up internal stresses is reduced to a minimum. There is no limit to the size of the work that can be welded.—Machinery, July.

INVESTIGATION OF ELECTRIC ARC WELDING OF STEEL.—D gest of Technologic Paper No. 179 of the Bureau of Standards. States that the mechanical properties of the arc-fused metal are essentially those of an inferior casting. A characteristic feature is the presence of numerous microscopic plates within the ferrite grains, but the effect of the grosser imperfections of the metal is so much greater than any possible effect of these plates in determining the mechanical properties that the conclusion appears to be warranted that this feature of the structure is a matter of relatively minor importance in ordinary arc welds.—Machinery, July.

TESTING COVERED ELECTRODE PROCESS WELDS.—These tests, carried on by the Anglo-Swedish Electric Welding Company of London, included tensile strength tests, rotary bending tests, impact tests and chemical analyses. In all these tests nothing was observed tending to throw doubt on the satisfactory nature of the work.—The Boiler Maker, June.

THE OXYGEN DRUM, by David Baxter.—An apprentice welder sets down the instructions he has received from the boss regarding the care of oxygen drums.—Acetylene Journal, July.

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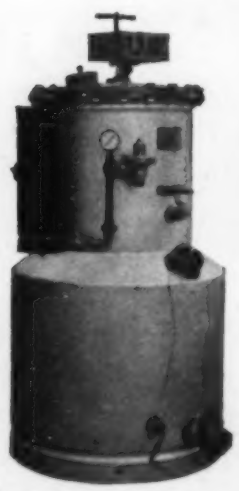

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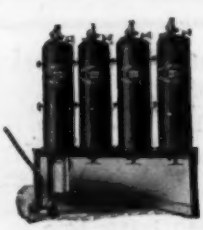

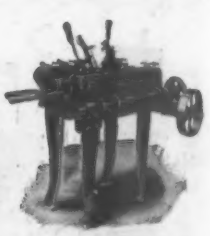

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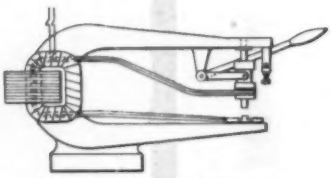

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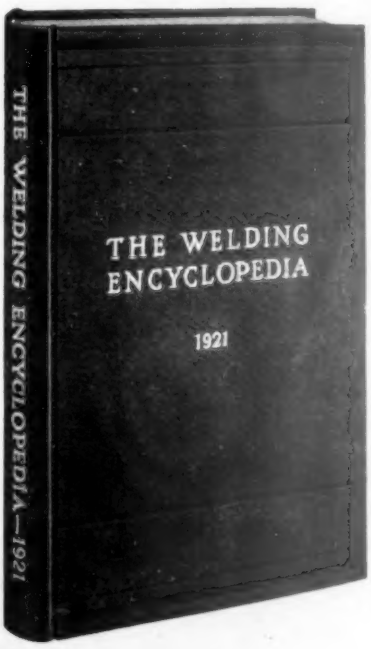

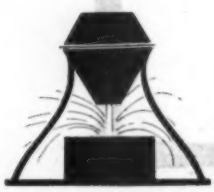

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